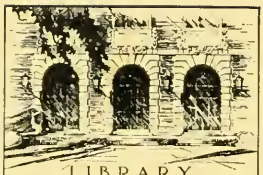
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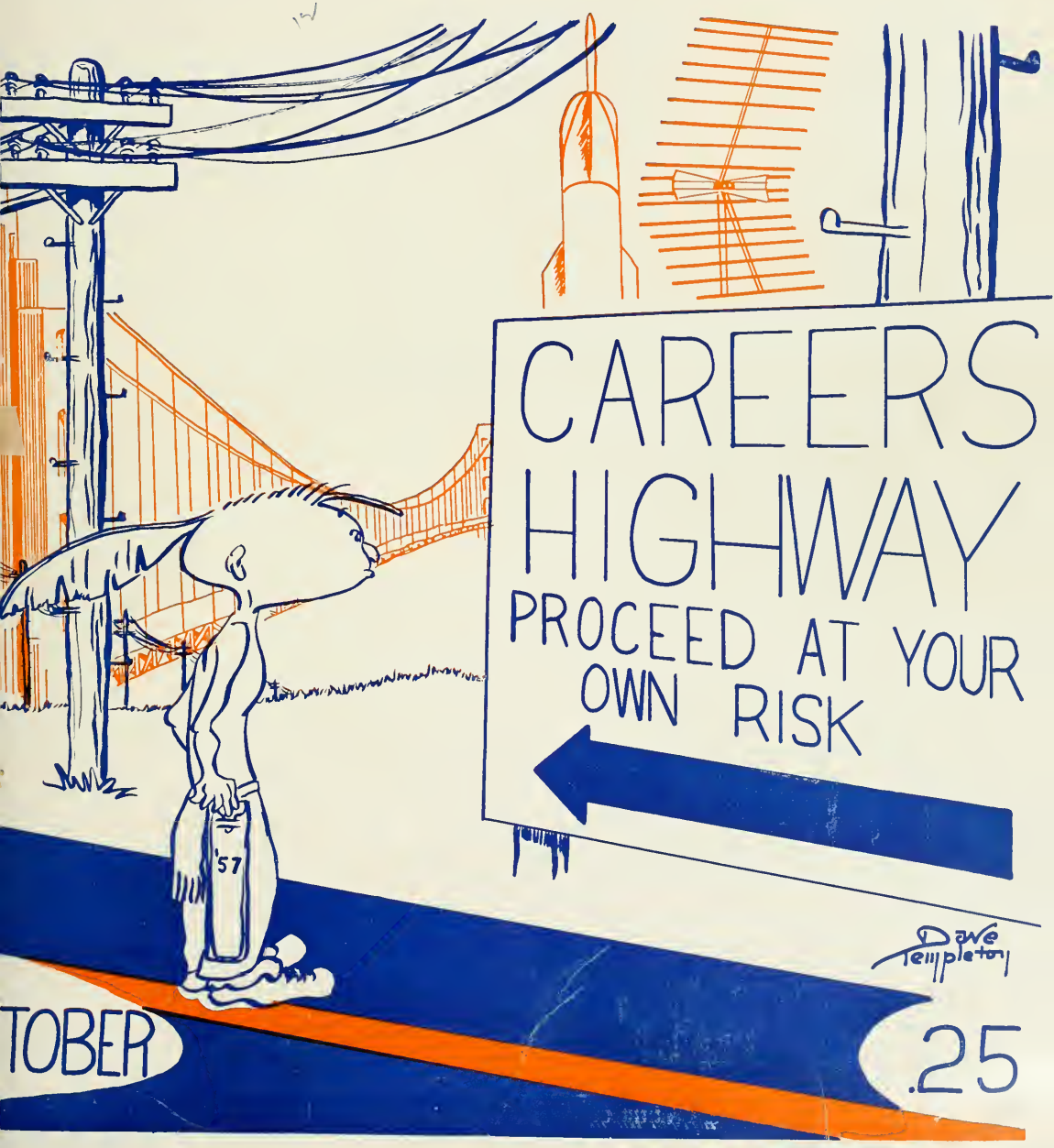

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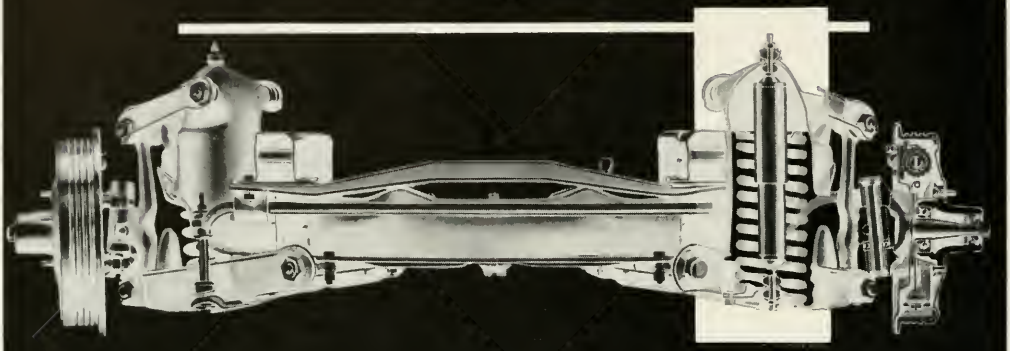
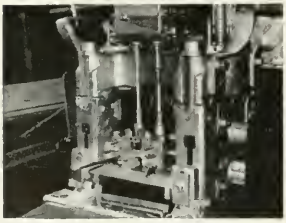
We gambled on the future

and the auto industry cashed in



● Here, at Muehlhausen Spring Division of Standard Steel Spring Co., precision-rolled U·S·S CARILLOY Spring Rounds are coiled without centerless grinding. CARILLOY Rounds have minimum decarburization, and they cost less to use.



● At the Gary Works of United States Steel, this precision mill rolls CARILLOY Coil Spring Rounds with extreme accuracy. Tolerances are half of standard: .004″ on the diameter, instead of the usual .008″, and only .006″ out of round, compared to .012″ on ordinary rolled bars.

IN the early days of the development of coil springs for front suspensions of automobiles, the only steel that was available was an ordinary hot-rolled bar from which as much as .035″ of metal per side had to be removed by grinding to insure freedom from harmful seams, pits, and decarburization. This cost money, was wasteful and time consuming.

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Published eight times during the year (October, November, December, January, February, March, April and May) by the Illini Publishing Company. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois, under the Act of March 3, 1879. Office 213 Engineering Hall, Urbana, Illinois. Subscriptions $1.50 per year. Single copy 25 cents. Reprint rights reserved by *The Illinois Technograph.* Publisher's Representative—Littell Murray-Barnhill, 605 North Michigan Avenue, Chicago 11, Ill. 101 Park Avenue, New York 17, New York.

THE ILLINOIS TECHNOGRAPH

volume 69 **number 1**

contents:

hear this, freshmen! ---- 9
the editors speak ---- 12
auto auto ---- 19
greetings freshmen ---- 23
ohm's law ---- 26
department of general engineering ---- 28
a day in the life of an engineer ---- 32
the need for more broadminded engineers ---- 36
introducing ---- 42
high speed electronic memory ---- 44
future demands in engineering ---- 48
atomic power generation ---- 52
skimming industrial headlines ---- 54
the man who is happy in engineering ---- 56
stylish steel bridge ---- 58
on the banks of the boneyard ---- 60
technocracks ---- 64

our cover

This month's cover depicts the broad opportunities and varied careers awaiting the new freshman in engineering. The road toward these careers, by way of his engineering education, is often difficult and involves many risks, however. The art work for this month's cover is by Dave Templeton.

our frontispiece

A view of the main entrance of the Illini Union. The Illini Union is the center of all campus activities at the University of Illinois. The Union provides lounges, meeting rooms, and recreational facilities for the student along with a cafeteria, dining room, and ballroom.

Hear This, Freshmen!

by Maurice Garnholz, Aero. E., '56

On behalf of the staff of the *Illinois Technograph*, I wish to welcome you, freshmen engineers, to the University of Illinois. You have probably been told by this time that this school is too big and too hard, along with many other things. True, it is a very large university, one of the largest in the United States in fact, but most Illini would, if asked, prefer it to a smaller school. Their reasons will probably be varied—more opportunities, always meeting someone new, many different friends—but they will be firm and good. We hope that you will come to like it as well.

MAURICE "MAURY" GARNHOLZ has been with the staff of the Illinois Technagraph for one year and is at present assistant editor. Maury's home is Hoyletan, Illinois, and his curriculum is Aeronautical Engineering from which he will graduate in 1956.

The first few weeks here can be expected to be somewhat difficult and confused. In an effort to be of some aid, I would like to offer some guidance and information which may prove of help throughout your whole first year here at the University of Illinois.

The primary purpose for coming to college is, conceivably, to obtain an education. Here at the U. of I., in order to remain and continue to acquire this education, one's grades must be sufficiently high. In all schools, including the College of Engineering, a 3.0 (C) average or better must be maintained to avoid going on probation. Many colleges here require a higher average. There are five letter grades used in the University, and each is assigned a value. The grades and their values are: A—5; B—4; C—3; D—2; E—1.

To encourage good scholarship among freshmen, and to give them recognition, two national scholastic honorary fraternities have been founded at Illinois. Phi Eta Sigma is the one for freshman men, and Alpha Lambda Delta is the one for freshman women. Both organizations require a 4.5 average. Membership in either of these organizations is a distinct honor and one well worth working for.

Phi Eta Sigma was founded at this University in 1923. It holds a smoker in December for those whose grades meet the entrance requirement. Initiation is held in March. P. E. and military grade *do* count in the average.

Many branches of engineering have their own honorary fraternities. Two of these include all engineers. These fraternities are the following:

1. Tau Beta Pi—all engineering
2. Sigma Tau—all engineering
3. Sigma Gamma Tau—aeronautical engineering
4. Keramos—ceramic engineering
5. Phi Lambda Upsilon — chemical engineering
6. Chi Epsilon—civil engineering
7. Eta Kappa Nu—electrical engineering
8. Pi Tau Sigma—mechanical engineering
9. Alpha Sigma Mu—Metallurgical engineering
10. Mu San—sanitary engineering
11. Sigma Xi—scientific research

Nearly all of these have national affiliations. They are organized primarily to recognize and promote scholarship, hence one has to be voted into them and must have at least the minimum scholastic average designated by the fraternity. A grade average of 4.0 or above is the usual requirement. If this is maintained your first two years, you are eligible for joining in your junior year. Membership in any of the above organizations is well worth the extra effort of study put forth to make the eligiblity grades.

The two social fraternities on campus which are composed entirely of engineering students are Triangle and Sigma Phi Delta. These houses are located on 112 East Daniel, Champaign, and 1103 West Illinois, Urbana, respectively.

Besides the honorary and social fraternities, there are numerous student professional societies here at the U. of I. Just about all that is required to enter one or more of these organizations is merely the desire to do so. Excepting some of the later ones, practically all the societies began as clubs and were later chartered as student branches by the parent national societies. The following names of the so-

Freshmen, this is the Student Counseling Bureau's IBM machine which grades your qualification tests and entrance examinotions. (Photo by Illini Photo Staff)

cieties are pretty much self explanatory as to what type they are:

1. American Ceramic Society—ACS
2. American Foundrymen's Society—AFS
3. American Institute of Architects—AIA
4. American Institute of Chemical Engineers—AIChE
5. American Institute of Electrical Engineers—AIEE; Institute of Radio Engineers—IRE
6. American Institute of Metallurgical Engineers—AIME
7. American Society of Agricultural Engineers—ASAE
8. American Society of Civil Engineers—ASCE
9. American Society of Mechanical Engineers—ASME
10. Illuminating Engineers Society—IES
11. Institute of Aeronautical Sciences—IAS
12. Institute of Traffic Engineers—ITE
13. Mineral Industries Society—MIS
14. Physics Society
15. Society of Automotive Engineers—SAE

As is readily apparent, each of these organizations is related to a particular field of work. With slight differences, nearly all are organized to promote interest in the parent group, to advance professional spirit and ethics, and to provide a meeting place for students, faculty, and eminent practicing engineers. At the meetings, which are usually monthly or bi-weekly, depending on the society, the programs usually feature students or prominent speakers from the large industries. Most societies also sponsor picnics, smokers, and ball games throughout the year. Often a society and the campus honorary fraternity in that same field jointly sponsor a banquet or picnic near the close of the school year. Incidentally, the members of Chi Epsilon, the civil engineering honorary fraternity, publish a small monthly paper, the *Benchmark*, which is distributed free of charge in Civil Engineering Hall.

The Engineering Council is a very worthwhile student coordinating organization. It or a similar group has been in action here at the U. of I. since 1894. In 1947 a constitution for a new Engineering Council went into effect, to coordinate the activities of the professional engineering societies, promote the interests of all engineering students in extra-curricular activities, and supervise such functions as St. Pat's Ball and the Engineering Open House. The Council consists of two representatives from each member society plus the editor and the business manager of the *Illinois Technograph*.

The Engineering Open House is an excellent opportunity for a student to learn more about his particular department and to come to know individual members of the faculty and students of that department much better. This presentation of engineering exhibits—most of them serious but some primarily amusing—began nearly fifty years ago. The various displays are designed to show visitors—both high school and college students and the many others who are interested—the methods and accomplishments of each engineering branch, as well as to give them a tour of the Engineering College's many buildings and extensive facilities. This Open House, now an annual affair, is held in the spring, usually in March or April. Many of you may have already seen it with your high school groups.

St. Pat's Ball, the "engineers' dance," is one of the University's big dances each year. Sponsored by the Engineering Council, it occurs each spring near the time of the Engineering Open House. The tradition of celebrating St. Patrick's Day with a dance originated at the University of Missouri about 1922. Working on this outstanding social event offers students an excellent opportunity to gain valuable experience and fun.

Another of the foremost engineering student activities is this, the *Illinois Technograph*. It has come a long way since 1886 when it began. It is now a monthly magazine—eight numbers being published each academic year. It has been a member of the Engineering College Magazines Associated since 1923, and incidentally, the ECMA National Convention, which is held in a different member college of the 35 in the association each year, was this fall held here at the University of Illinois.

The *Tech* prints material prepared by the students, graduates, and on occasion the faculty of the College of Engineering. The *Technograph* staff is composed of engineering students who are interested in writing and editing or in the business procedures of publishing and distributing a magazine. These activities serve as an absorbing hobby to the student, and the student is able to gain valuable experience by his participation. In the past this activity has proved invaluable in encouraging students to prepare technical material for presentation to societies and for later publication. If any student is interested in journalism, writing, publishing, business administration, advertising, or any of the widely varied jobs this activity entails, come to the *Technograph* office in 213 Civil Engineering Hall, Urbana, or phone University Extension 2493. We of the

"Please sir, not a Saturday class." This cry was heard often as students had their schedules checked and classes assigned. Photo by Illini Photo Staff)

Technograph staff will be glad to give any information we can about our organization.

Besides the engineering activities, students enrolled in engineering also take part in the great variety of activities—athletic, social, forensic, dramatic, military, musical—open to all University of Illinois undergraduates. The services and functions of the Illini Union are very diversified and will very likely interest nearly everyone in one phase or another. For more details, stop and ask at the information desk in the first floor lobby of the Illini Union.

During the latter part of Freshman Week, an Activity Night was held in Huff Gym. All the campus activities had displays and demonstrations of what they do. In a campus group as large as Illinois' student body, there is bound to be some activity you will like. The *I-Book*, available to any freshman at the YMCA, lists many activities and tells about their organization and the people who are currently working in them.

All of this talk about the opportunities open to engineering students in the line of activities may seem somewhat needless, for one of the foremost questions in the minds of many students is: "Why take part in extracurricular activities? I'm going to school to study, not to waste time." The answer to this question is fairly simple. Important though the gaining of knowledge and the development of your mental abilities are, they are not the sole aim of education. Equally important is the growth of a personality which will inspire confidence and develop friendships among your colleagues. This may be accomplished in a very enjoyable way by participating in student activities.

A great many engineering students feel that they don't have enough time for extracurricular activities. They say that they can't participate in these activities and still do justice to their studies. Actually, the attitudes you develop by participating in the activity help you to study more effectively. This in turn more than makes up for the time you will spend upon the activity. In addition you learn a great deal about how people's minds work. And as you proceed forward in your professional experience, a knowledge of human, as well as material, processes becomes essential. In fact, extra-curricular activities provide a laboratory in human relations.

Lastly, an activity offers you a means of relaxing—something that every college student needs. Like a hobby in later life, an activity of some sort provides a release from the strains and tensions of the day-to-day grind.

The University has placed at the students' disposal a number of agencies and departments designed to help one solve the problems likely to be encountered in the four-year trek through school. Among these is the Student Counseling Bureau. You will probably first become acquainted with some of the services offered by the Student Counseling Bureau when taking the guidance exams during Freshman Week or the summer previous to that time. Sometime

If you were puzzled by the procedure at registration, don't feel bad about it. Here, Bill Hannen, senior architectural engineer, ponders the problem. (Photo by Illini Photo Staff)

after taking the many aptitude tests, I. Q. tests, English exams, mechanical tests, etc., you may go to Room 311 Administration Building, East Wing, and ask for an appointment to find out the results of those tests. These tests are nearly all machine graded by an IBM machines, such as the one shown in the picture that accompanies this article. It is one of the first truly electronic machines of its type. The papers are graded by having a small current passed across the lead pencil marks which act as conductors, if they are in the right place. Think you can cheat it? Perhaps, but don't try, for all answer sheets are looked over beforehand for unusual or out-of-the-ordinary markings. Anyway, use of tricks in an effort to obtain a better score will not indicate your true abilities, and the tests are given to find them and thus be of help to you.

The Student Counseling Bureau will also aid you in any problems which you may have. About 60% of the freshmen in the University make use of the Bureau services, either before they actually enter the University or during their first year. These services are yours for the asking. The Bureau will not tell you what you *should* do, but it can supply you with information about your abilities, interests, and personality which you could not get in any other way, and it can help you use this information in arriving at sound conclusions about selecting a course of study and a later vocation. It makes sense to utilize sound scientific techniques and psychological information as aids to greater self-understanding and more effective living. It makes sense to seek the services of professionally trained counselors in planning a career or in making important personal decisions.

As in the case with your doctor, all information disclosed in counseling interviews is kept strictly confidential. Reports of interviews and of conclusions reached are not availavle to your instructors, your deans, your parents, or anyone else, unless you yourself request that such reports be made. For an appointment, go to Room 311, Administration Building, East Wing.

Remember, the Student Counseling Bureau can prove invaluable in the help it can offer you in choosing a career, in developing more effective study and reading skills, and in personal and social adjustments.

If you find that you need advice or aid in revising your engineering curriculum later in the year, or if you have any other troubles, it is often wise to go see one of the Deans of the College of Engineering. They will be glad to help you. Their offices are in Civil Engineering Hall; the exact rooms are listed on various bulletin boards throughout the building.

Even if it isn't now, it will soon be evident that not more than a hurried glimpse of the opportunities and a brief attempt at guidance to them for the freshman engineer can be given in the limited space available here. For more information ask at the information booths in the Illini Union or the Administration Building. Also the pamphlets, *Facts for Freshman* and *Careers in Engineering*—available from Dean W. L. Everitt's office in Civil Engineering Hall—may prove to be of great assistance.

Yes, the University of Illinois is a large place, and the students composing it are many and varied. It is often compared to the military services in that it can "make you or break you." It is entirely up to you. But only by associating with other students, faculty members, and activities can you develop the broad mental outlook and personality you will need for a successful career and for effective citizenship. The opportunities are here; it is up to you to take advantage of them.

With this issue, our first for the 1953-1954 school year, the staff of the Illinois *Technograph* welcomes the incoming freshmen, for whom the edition has been especially prepared.

The Freshman engineer, even at the successful completion of his first year, often has little idea of what is ahead. His courses, attitude, and outlook are all very general. We hope the features this month and in succeeding months will help the freshman student crystalize his outlook. How can the *Technograph* do this? The answer to this question is neither short nor simple.

The *Technograph* has been a public relations contribution of engineering students and graduates for well over three-quarters of a century. In continual cooperation with the college of engineering, the *Technograph* has in the past and shall in the future make every attempt to help and advise the freshman engineer, anticipate a few of his demands and requirements, and occasionally offer, if we may be so bold, a few words of wisdom.

The freshman may ask "how can the *Technograph* help me in my first year of engineering? Surely the *Technograph* cannot take my hour exams and finals; it cannot assure me of a high average." This is true; however, the *Technograph* is a common meeting place for new ideas and developments, new personalities and their contributions, and general "shop" talk of the college of engineering.

Each branch of engineering has its trade journals, with articles of interest to a specific field. The *Technograph* presents a cross-section of their articles and is in itself the trade journal of the engineering student at the University of Illinois and is of interest to all concerned with engineering. Industry wants men who are up with the latest developments in the field. Take inventory of your own knowledge on latest developments and methods, even in your chosen branch.

This issue contains many articles of interest to the freshman, such as Dean Everett's letter, Maurice Garholz's article, "Hear This Freshmen," and other articles prepared especially for freshman.

Freshman, we want you to become better acquainted with the *Technograph*. The editors hope that this policy will work both ways. We want to know our readers better. The *Technograph* is always anxious to hear from you and have your impressions, suggestions, and general critique, of the magazine; therefore, a "letters to the editor" column will appear in the November issue. Send in your complaints and gripes; we need your suggestions and help to produce a constantly better magazine. We shall do our best to maintain your confidence and support.

It must be remembered that Green Street is more than a campus thorough-

THE TECHNOGRAPH

PUBLISHED ANNUALLY

BY THE

ASSOCIATION OF ENGINEERING SOCIETIES

OF THE

UNIVERSITY OF ILLINOIS

VOLUME XXII

1906—'08

UNIVERSITY OF ILLINOIS

CHAMPAIGN OR URBANA

1908

fare. This street separates the engineering and non-engineering departments of this University. The Daily Illini keeps the student body posted on general campus and international affairs; the *Technograph* is the chief spokesman for the engineering student body. However, the continued and loyal support of the entire engineering campus is needed if the *Technograph* is to function well as a spokesman. Our advertising is national; our encouragement and leadership must be local—through the college of engineering and the students therein. As a component we are no stronger than our weakest link.

The four years spent in college will pass all too quickly. Many students, in later years, regret the fact that they did not accept as much as they possibly could from their education. College life is more than attending classes. College life is assuming an objective attitude and developing a well rounded personality that will wear well in the years ahead. Read the *Boneyard* and the *Technocracks*. Review the technical articles; become acquainted with campus leaders through *Introducing*. Subscribe to the *Technograph*, as your support is the mainstay of our existence. This magazine is for you, students.

For the alumni, we would like to announce that as of the November issue, a column of alumni news will appear as a regular feature. The 1908 frontispiece was sent in with a subscription order by Frank Randall, Jr., class of 1940. Alumni in the field have, in the past, been a valuable aid, and the *Technograph* desires to extend the alumni contact to a new height in the 1953-1954 season. We hope a large number of Illini Alums will contribute to the *Technograph* in the future.

FOREWORD.

IN publishing the Technograph, the attempt has always been made to rise somewhat above the general college periodical, into a sphere which may contain some interest for the graduate, or the practicing engineer. We present in this issue some material which we think worthy of notice, both from its practical value, and from the fact that it shows to what an efficient point our facilities for research have been raised.

We wish to urge all those interested in the Technograph to pay due heed to our plans for next year, and, if such a change as is proposed is consumated, to give all possible assistance to the project.

Reprint of Foreword from 1908 Technograph.

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Chairman

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TECHNOGRAPH

November Issue Will Be on Sale

NOVEMBER 14

TOPIC: SPACE TRAVEL

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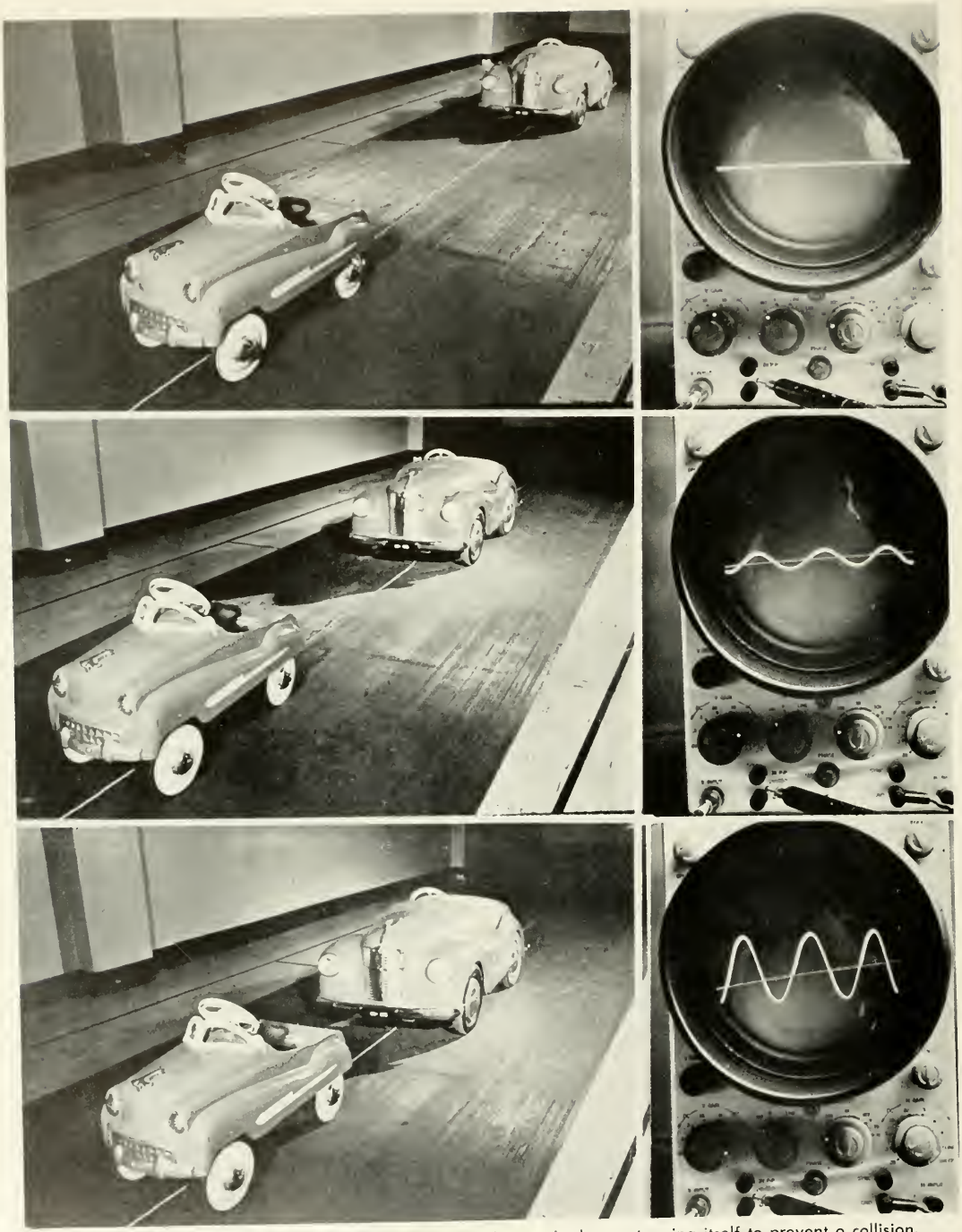

Model car equipped with experimental electronic equipment is shown stopping itself to prevent a collision. Designed by Dr. V. K. Zworykin, RCA scientist, to study electronic control of automobiles on superhighways, the car at the rear picks up a warning signal generated by the metal of the parked car in front. Oscilloscope pattern at right of each picture shows how the warning signal received in the rear car gets stronger as it nears danger point.

see the . . .

Auto Auto

edited by Paul E. LaViolette, E. E., '55

An exploration of how electronics can be put to work to reduce highway disasters and to relieve drivers of tiresome tasks on modern superhighways has been initiated by Dr. V. K. Zworykin, pioneer television and electronic scientist of the Radio Corporation of America.

Recent electronic advances, such as the tiny, power-thrifty translator, indicate that electronic aids to many automobile driving problems are approaching the realm of practical application, according to Dr. Zworykin said, certain electronic devices to assist drivers in such matters as bad weather steering and collision prevention are nearer at hand.

To study the basic problems of automatic driving, Dr. Zworykin and assistants at the David Sarnoff Research Center of RCA, in Princeton, N. J., have equipped a model five-foot car with electronic equipment. This laboratory car, which is powered by a storage battery, can:

1. Steer itself along a prescribed route.

2. Stop itself when approaching a metal obstruction.

3. Turn out of its original lane into a second lane as if to pass another car moving at a slower speed.

In the laboratory set-up, the model car is guided by a wire which represents a cable that would be laid in the roadbed of a superhighway. The wire sets up a magnetic field of a certain frequency which is picked up by the two coils, one on each side of the car. If one coil receives more of the signal than the other it means the car is no longer centered over the wire and electronic equipment controlling the steering wheel immediately brings the car back "on course."

To prevent a collision with an obstruction, simple transistor circuits associated with the guidance wire send out warning signals (of another frequency) whenever an obstruction passes or is stalled over them. These warning circuits, in effect, produce a "radio tail" at the rear of any sizeable metal obstruction on the route. When equipment in the model car receives the warning signal, the brakes are automatically applied and the car comes to a halt.

To stimulate two lanes in the same direction, Dr. Zworykin has parallel guidance wires with a diagonal wire connecting them. When the model car senses the radio tail of an obstruction in the inner lane, its electronic equipment shunts it along the diagonal into the outer lane so as to pass the obstruction.

A system of warning circuits in the roadbed to produce a "radio tail" when an automobile passes over would be quite impractical with electron tubes, Dr. Zworykin pointed out. Such circuits would be needed approximately every 20 feet and the electrical power to operate the tubes would be enormous, he said. But when transistors are available in large quantity at low cost, he said, such circuits become feasible because power consumption would be reduced a million fold over that required by tubes.

In experiments with the model car, Dr. Zworykin has been assisted by L. E. Flory and W. S. Pike, RCA research engineers.

Discussing the trend toward modern highways on which driving is becoming both simple and tiresome, Dr. Zworykin said that "the time has arrived for consideration of automatic driving techniques which may relieve the driver of his routine duties whenever his car enters an express highway system.

"Even now," he said, "with power steering, control devices are used to guide the car in preference to direct steering. Similarly, with power braking, the driver supplies a control signal rather than the physical force required to slow or stop the car. The automatic headlight dimmer is another device to take over a routine function of the driver.

"The number of such devices may be expected to increase and it is not too early to examine ultimate objectives of driving simplification. Long-range advance planning appears essential in this field in view of the large number of parties vitally concerned. Successful development depends on the cooperation of governmental authorities, the highway builder, the car manufacturer and the safety engineer for the benefit of the individual driver and the public at large.

"The basic requirements of an automatic driving system harmonize with trends in modern highway construction," Dr. Zworykin continued. "The requirements are that the roads have at least two lanes in each direction and that crossings and left turns across traffic be eliminated by cloverleafs and similar systems. With these conditions satisfied, the stage is set for a gradual introduction of measures to reduce traffic risks and simplify driving procedures.

"The changes should necessitate neither sudden abandonment of established driving habits nor wholesale installation of new equipment on roads and vehicles. This means: (1) The driver must retain the freedom of choice of speed, within prescribed limits, and of choice of either manual or automatic control. (2) Automatic control systems must be restricted, initially at least, to high-speed long-distance road systems subject to special regulation, such as turnpikes and thruways. (3) Vehicles equipped with automatic driving devices must be able to benefit in mixed traffic, consisting of equipped and unequipped vehicles.

"It is clear that car owners and purchasers will not bear the added cost of the control equipment unless it proves useful under current conditions, namely with the vast majority of cars under purely manual control. At the same time it would be both politically and economically impractical to restrict traffic on high-speed road systems to equipped cars.

"As a first step, equipment should be provided to enable the driver to keep his vehicle centered on the traffic lane under conditions of fog and poor visibility in general. This may be accomplished by a cable, buried in the concrete, carrying moderate-frequency alternating currents (of the order of 100 kc) and a pair of magnetic pickups mounted on the car. The difference in the signals derived from the two pickups may be used either to indicate the off-course position of the vehicle on the dashboard or applied directly to the steering mechanism so as to maintain the car in the center of the lane. Feedpoints for the cable may be provided at intervals along the highway.

"In this system the driver not only would retain complete control of the car speed, but, in addition, could switch at will from manual to automatic steering. The automatic setting could be linked to an external indication on the car to inform road supervisors and other drivers of the fact that the car is under automatic control.

"The second step in the evolution of the automatic driving system, the prevention of collisions, is a natural extension of the guidance equipment.

"The essential feature of one proposed collision prevention system is the trans-

fer of energy from a high-frequency power cable to a series of tiny oscillators or transmitters along the lane. The transfer of energy is controlled by the passage of a car, and a long time constant circuit or 'memory' causes the transmitter to function for a time after the car has passed. The oscillations are transmitted backward along a high-attenuation cable and sensed by pickup coils on the following cars. Thus every car, whether equipped with automatic driving devices or not, would be followed by a 'flying tail' of warning signals. Their amplitude would increase as the car slowed down, and become a maximum for a stalled car. Conversely, the sensing system of the following cars would be coupled with the car speed indication in such fashion that the warning signal would increase with their speed.

"In a completely automatic system this warning 'tail' could be used to switch a car from one lane to another at specified cross-over points. In this case, the sequence of events as a car approaches another vehicle which is either stalled or moving at a lower speed is: As the signal picked up from the 'flying tail' of the preceding vehicle reaches a certain level, the guidance setting would be shifted to the left lane. Then, the car would pass over to the left lane at the next cross-over point and pass the slower vehicle unless:

a. The turn-off is blocked by signals from a nearby vehicle which is already in the left lane, or

b. The slower vehicle impedes further progress even before the turn-off point is reached.

"In the second instance the signal from the 'flying tail' would continue to increase in intensity. Its indication to the driver may be either auditory or visual —in the form of a sound of rising amplitude or a flashing light of increasing frequency, warning him to decelerate or apply the brakes. As an alternative, the signal, from a certain level on, may reduce the fuel intake and, at a still higher level, actuate the power brakes. Again, by a three-way switch, the driver could be given the choice of unassisted manual control, manual control assisted by instruments indicating his position and the proximity of other vehicles, and of completely automatic guidance and collision prevention.

"Full automatization of the driving process can be envisaged as the final stage of the development. In addition to the installation of guidance and collision prevention equipment on the roads and in the vehicles, this would involve automatic inspection of the vehicle equipment and a continuous recording of traffic conditions at the gate stations. Indications of the position and velocities of the vehicles along the road section between successive stations would aid supervising personnel in the problem of traffic distribution. In addition, it would give immediate notification of breakdowns requiring emergency action.

"Freight transport along the highways presents one of the most challenging applications of full automatization. The establishment of a network of truck routes, separate from a highway system designed for passenger vehicles only, has been discussed repeatedly.

"With full automatization, it offers the possibility of driverless freight transport over long distances, with route terminals taking the form of marshalling yards. Here, small dispatching crews would send out the loaded trucks to their distant destinations and assign incoming vehicles to drivers for local delivery of the consignment. Assuming a cruising speed of 30 miles per hour, a separation between vehicles of 100 feet, and an average truck load of 5 tons, a one-lane route could handle nearly 200,000 tons a day. This large shipping capacity provided with minimum manpower requirements would do much to alleviate present bottlenecks in the delivery of consumers' goods and industrial raw materials."

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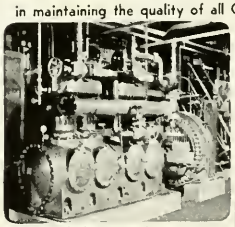

Frick 4-cylinder ammonia compressor at D. L. Clark Co., Pittsburgh. Motor has 300 hp.

There's hardly a business that cannot profit from the use of similar Frick cooling equipment.

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GREETINGS, FRESHMEN

From Dean W. L. Everitt

DEAN EVERITT

This is the fifth year during which I have, through the *Technograph*, greeted our new engineering students. One of my friends asked me a few days ago, "Don't you find it a chore?" My answer was, "Anything but. I like to do it, and my only worry is whether what I say will be of some real use."

There are many reasons why I like to write this page each year.

For one thing, all of us who teach in engineering colleges are happy when able young men and women enter on an engineering career. We know, as probably you know, how greatly the United States and the whole free world need technically educated people. There aren't enough of you. There won't be enough for as far in the future as we can foresee. This fact puts a heavy responsibility on us, on you, and on industry.

Our responsibility as teachers and administrators is to give you the very best education we can. And not merely what is the best education in 1954 or even 1958. We have to try to look forward and see what the engineer should know and be able to do ten or even twenty years from now. For example, how much greater a role will such sciences as electronics, physiology, and psychology play in the work of one or another large class of engineers in the 1960's or 1970's? How much of the rapidly growing knowledge of the art and science of communication should you men and women learn? Will your civic obligations be even greater than those which engineers have carried in the past? Can and should we stimulate you to a greater personal enjoyment of literature, music, and the other arts?

You can already see what some of your own responsibilities are. The successful engineer has always been a creative planner and doer. But sometimes he has taken longer than was necessary to see the value of creativeness and to think and act creatively. If your college years are to start you on the road toward creativeness, you will have to cooperate with your teachers in the exercise of your initiative, your ability to see and formulate problems, your judgment in meeting them. In fact, you will have to carry the greater part of the load. For it is a truism that teaching, properly understood, means providing the facilities and the stimuli for learning. It is not too much of an exaggeration to say that there are no teachers; there are only learners.

What of industry's responsibilities? Well, they certainly include making a fuller use of the engineer than many companies have done until recently. Too many firms have used engineers in technicians' jobs. Too many firms have failed to see that one big characteristic of the engineer —perhaps his distinguishing characteristic—is his ability to design and plan. A change is already taking place. It is a change which, we hope, will mean that the numerical shortage of engineers can be partly made up for by a wiser use of those whom we have.

I know that you will not misinterpret this situation nor try to turn it to selfish advantage. The question is not how much money you make on your first job—though we hope you make a lot. The question is not of the title that gets put on your office door. The question is one of your being given an opportunity to apply your truly professional abilities for the good not primarily of yourself or even of industry, but of society as a whole.

I have talked of "heavy" responsibilities. But this doesn't mean that the process of assuming them and carrying them must be heavy in the sense of sober and humorless. Engineering can be fun. In fact, it is fun for all successful engineers. They couldn't do without the challenges. They couldn't even do without the headaches. These stimulate them, keep them toned up, are among their sources of constant enjoyment.

I will go one step further. Engineering education can be fun. I hope you will enjoy the classroom, the lab, the inspection trip, your conferences, your bull sessions, and the host of extra-curricular activities that a large University and its College of Engineering provide. I hope you will take part in the affairs of the professional societies, in the Engineering Open House, in publications, or in dramatics or music. Not to forget athletics. I hope you will continue your affiliations with the church of your choice. I hope you will continue to read widely, or if you have not yet formed that habit, that you will begin to form it.

Don't look on these activities as duties. Look on them as opportunities. Above all, look on them as fun. A famous English writer once said of his countrymen, "They take their pleasures sadly." The less sadness we have around the College of Engineering, the better engineers we shall produce and—what is really important, since we are only agents—the better engineers and citizens you yourselves will be.

Austin Bush, Rensselaer, '50, Helps Develop New Pump

AUSTIN BUSH, inspecting stuffing box assembly on boiler feed pump.

Reports interesting project engineering assignments at Worthington

"Despite its size as the leading manufacturer in its field," says Austin Bush, "I have found Worthington pays considerable attention to the interests of the individual. The company's excellent training program consists of several months of working with the various types of equipment manufactured, augmented by technical lectures, and talks on the organization of the corporation.

"Following this training, I was given an opportunity to choose the department in which I wanted to work—engineering, sales, or manufacturing. My choice was the engineering department where I have already been assigned to several interesting projects.

"In addition to the training program, the members of our engineering department hold monthly seminars at which engineering topics of general interest are discussed.

"Opportunities for advancement are good, and pleasant associates make Worthington a fine place to work."

When you're thinking of a good job, think *high*—think *Worthington.*

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, New Jersey.

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What's Happening at CRUCIBLE

about Alnico Permanent Magnets

You will find Crucible Alnico Permanent Magnets in products ranging all the way from cuff links to magnatrons. Here are just a few unusual applications in which these magnets were used to simplify or improve a product.

This is Warren, age 4, a cerebral palsied youngster, using magnetic toys in therapy-play.

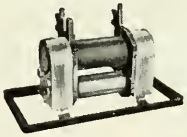
Magnetic Toys Cerebral palsied youngsters at the Children's Rehabilitation Institute, Cockeysville, Maryland, are unable to play with normal toys. Their lack of muscular coordination and control, causes ordinary blocks or toys to slip through their grasp and fall to the floor. Crucible helped overcome this problem by imbedding small permanent magnets in the toys. By using these magnet-equipped toys on metal topped tables, the children are able to control them much more easily.

The Children's Rehabilitation Institute has pioneered techniques to help these handicapped children gain maximum muscular control and coordination. Experience at the Institute has shown that the use of magnetized toys helps develop coordination in hand and arm use, and in grasping and releasing.

Cuff Links One manufacturer of cuff links had a happy idea. He replaced the stem with a magnet assembly designed by Crucible magnet engineers. The tiny, powerful aspirin-sized magnets used, gave the finished product a holding force at the pole plate as high as 80 ounces troy.

Enlarged cross section view of one cuff link.

Telescriber-Recorder In one application, for this instrument that transmits written messages over wire, two permanent magnets were being used to match the electromagnetic fields. Assembly time and unit costs were high. Crucible magnet specialists designed one permanent Alnico magnet to replace the two. Magnet costs were cut 50% ... and efficiency of the unit was increased.



Top bar Crucible Alnico; lower bar (replacing former 2nd magnet) provides return path.

Engineering Service Available

Perhaps your magnet problems are entirely different from these. Whatever they may be, our staff of magnet and electronic engineers will be glad to tackle them, and to work with you in meeting your magnet requirements. Don't hesitate to call us when you have an application for permanent magnets.

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OHM'S LAW

edited by Roger Funk, E. E., '56

Inspector Sherlock Ohms of Standard International Yard was driving across the Wheatstone Bridge in his '09 Maxwell, trying to remember Ava Gadro's number, so he could call her and date her for the Policeman's Ball, when suddenly he blew a tire.

"Oh Nernst!" said Sherlock, "I don't have a tire ion with me, but luckily, ammonia short distance from the Ideal Gas Station, run by my friend Saul Vent, who at the moment is freon bail."

Just as Inspector Ohms emerged from the Ideal Gas Station, his tire all fixed, a rubber policeman whizzed by him with his Carnot Cycle going at full speed. Ohms knew he was deuteride by, but he wondered watt made him rush so. He shouted atom, but he was gone. His reaction was instantaneous as he whipped out after him. By radio activity he learned that Mike Rofarad, Recipro City's top-rankine rookie, was chasing a suspected joule thief. Ohms chased him down Elect Road, around the Dextro Rotary, back over Salt Bridge and up into Farren Heights. He turned left at the Old Ball Mill, down past the Mono-Clinic, the Palladium, where there was a mathematical convention, and all the way to the liquid junction at the Endothermic Street. They were almost across the city line when Sherlock's car swerved, and crashed into a can der Waal. The Raman effect ruined his differential, so he couldn't go beyond the limits in it. He quickly volted out of the wreck and took up the chase on foot. He soon came across Mike, standing in a magnetic field, holding Ann Hydrate and Al Doll at bay.

"Watts the meaning of this?" queried the inspector, and the Copper was quick to explain:

"Well, Sir, I stopped in at the Invar Bar, a local dyne and dance spot, for a couple of quartz of Lambert Beer when I noticed Ann Hydrate sitting alone at a two-place log table. I knew some joule thieves had made a radon Ethyl Benzene's country estate, and I spotted one of the Benzene rings on her along with a para Ethyl's earrings. Anode an explanation of this but before I could torque to her, she was into her coat of rust and out the door. True to the Kopp's rule, I was quick to follow when I saw her get into her Mercury Chrome 8. I knew I was infra tough chase. However, her engine started Fehling just beyond the city limits and I caught her. She had lead me to the missing joules and her accomplice, Al Doll, who was about to Barium in a hollow, common log under the square roots in this deserted magnetic field!"

"Son, you'll go on nights for this!" beamed Ohms. This in effect was a promotion, for in Recipro City nitrates are much Mohr than those faraday men.

This was first printed in the Boston College *Chem Bulletin.*

In his later years the famous cellist David Popper, wore a jet black mustache although his hair was snow white. A friend asked him for the reason of this discrepancy. "That is simple," replied Popper. "My mustache is twenty years younger than my hair!"

* * *

On his way to the train Glenn encountered his Bishop. What's your hurry?" asked the Bishop. "There's plenty of time." Glenn told him he was trying to make the 10:20.

"That's what I thought. I am taking that one too. We have 20 minutes . . . why not walk?" replied the Bishop.

Upon arriving at the station they found that the 10:20 had departed. The Bishop's watch was 15 minutes slow. "Do you know, Glenn, I had the greatest faith in that watch," remarked the Bishop, comparing it with the station clock.

Commented Glenn solemnly: "Of what use is faith without good works?"

* * *

Woman: "It's so good of you, doctor, to come this far to see my husband."

Doctor: "Not at all. I have a patient next door, so I thought I'd just kill two birds with one stone."

Fafnir Precision Instrument Bearings for an Automatic Pilot and Approach Coupler

The handful of Fafnir Ball Bearings illustrated, help to assure the success of an amazingly ingenious, 36 lb. Automatic Pilot and Approach Coupler for jet planes. These instrument bearings, 22 in all, weigh less than 4 ounces. Their compactness, extreme sensitivity and dependability are vital to the instrument system's design and performance. Fafnir Extra-Small Ball Bearings for extremely small shafts are available in various constructions and tolerances to meet exacting requirements. The Fafnir Bearing Company, New Britain, Conn.

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A sound-motion picture depicting high points in the manufacture and use of Fafnir Ball Bearings is available to engineering classes. Write to the Fafnir Bearing Co., New Britain, Conn. for details.

Two agricultural scientists, from a large state university, check the blue print for irrigation pipe on Republic's experimental farm.

HERE THE CATTLE ARE GUINEA PIGS

If you're going into industry, one of your most difficult tasks faces you in the next few months. You'll have to distinguish between progressive companies and stand-stills. One way is to consider the pioneering each is doing.

How much does this company you might join plan its future?

How much does it care about society in general?

The cattle in the picture, for instance, are at Republic's experimental farm. They are part of a study to determine how much extra grass, hence extra meat, can be produced by irrigation. The purpose of the experiment is to prove the benefit of converting worn-out crop land to profitable grazing area.

The economic reasons for Republic's experiment are that animals must be fenced and Republic makes steel farm fence; also that irrigation requires pipe and Republic makes steel irrigation pipe. But beyond this immediate commercial aspect, Republic's experimental farm has a goal reaching far into the future.

Republic Steel's policy is based on a deep realization that no economic or social section of a nation can long progress at the expense of others. Progress must be mutual and industry has a responsibility to *do for* its customers as well as to *sell to* them. This, we believe, is an enlightened approach to economics which will promote the continuing welfare of all.

We hope such research programs, of which our farm experiments are only one example, will catalog Republic in your mind as a progressive, forward-thinking company.

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General Engineering

by Paul E. LaViolette, E. E., '55

The newest Department in the College of Engineering has made its appearance in time for the fall semester. Incoming freshmen will be glad to find a newly, well-organized department empowered to grant degrees in General Engineering in place of the almost interdepartmental shuffle that had taken place in previous years.

The curriculum offered by the department is designed for students who do not wish to pursue the more specialized engineering curricula with their greater emphasis on test procedures and design, but who wish to secure a sound education in engineering principles and their application. With the completion of the normal 4 year course (which is flexible enough to allow sales engineering and management options) a degree of Bachelor of Science in General Engineering will be conferred.

Although the department has just recently been organized, General Engineering students have been graduating from the Engineering College for a number of years. Men such as Professor R. P. Hoelscher, now head of the department, Dean H. H. Jordan (retired), Professors C. H. Springer, A. J. Friedrich and J. S. Drobrovolny and many others in what had been formerly General Engineering Drawing, helped teach and advise these students. Dean Jordan, who retired just this September after 42 years with the College of Engineering, did much to develop the General Engineering Department.

The General Engineering curriculum was begun in 1922 and the first General Engineering student was given his diploma in 1923. Since that year more than 500 students have graduated in this field. Enrollment has steadily increased so that at the end of the spring semester of 1953, 119 students were enrolled in General Engineering. This fall should bring the total to 151 making it at its very start as a Department the fifth largest in the College.

Much of the former curriculum has been retained, but several new courses have been added such as "The History of Engineering," "Engineering Reports" and others that tend to round out the curriculum.

The "Society of General Engineers" has been reorganized on the campus, also. Discontinued during the war after an existence of 20 years because of lack of students, it was reopened in the spring semester of this year with a membership of 25. William E. Getzen was elected president and Professors S. G. Hall, R. W. McDonald, T. C. Hartley and J. S. Dobrovolny agreed to act as sponsors.

Freshmen who are in doubt as to what they actually want to specialize in in Engineering might do well to consider General Engineering as an excellent field of study. Enveloping the whole field of engineering as it does it gives amazing insight into the problems that all types of engineers are constantly being confronted with and is therefore almost a necessity for managerial positions. Small industries are constantly clamoring for trained men who know the overall picture and can get things done quicker and cheaper because of this knowledge. Students interested in this field are invited by the Department to drop in at any time with their questions. Department offices are on the second floor of the Transportation Building.

Professor Randolph P. Hoelscher, head of the Department of General Engineering. (Photo by Tucker Nason, Illini Photo Staff)

ectrical wires and cables

Natural rubber, including Laytex®, GR-S synthetic rubber and thermoplastic insulations are available in two classes, depending on whether they are designed for use in dry or wet locations. Standard insulations, Type R and Laytex Type RU (made from rubber) and Type T (made from thermoplastic) are for use in dry locations while moisture-resistant insulations Types RW, RUW, and TW are for use in wet locations. There are many installations, particularly in buildings, where the less costly standard compounds give entirely satisfactory service.

Natural rubber and GR-S synthetic rubber insulations are also available in two classes depending on the operating temperature for which they are designed, namely, Type R and RW for 60 C. operation and Type RH and RUH for 75 C. operation. Conductors insulated with RH insulation carry more current, that is, use the conductor more efficiently than those insulated with Type R insulation. There is also available a combination insulation capable of operating at 60 C. in wet locations and 75 C. in dry locations. Butyl rubber insulation is suitable for operation at 80 C. and silicone rubber for even higher temperatures.

The thermoplastic insulations described above are limited to 600 volts for general power distribution. The rubber and rubber-like insulations are limited to a maximum operating voltage of 5000. For operation at higher voltages where ozone is produced in quantity, resistance to ozone in the insulation must be provided.

Acceptable ozone resistance in rubber and GR-S synthetic rubber insulations is provided by incorporating in them relatively high percentages of an inert or chemically saturated compound such as vulcanized vegetable oil. These are the so-called oil base compounds. Compounds made from butyl rubber are inherently ozone resistant. Oil base and butyl compounds are suitable for operation at a maximum voltage of about 28 KV, grounded neutral, when properly shielded.

Varnished cambric insulated cables are generally used in the same voltage range as ozone resistant rubber, that is, at a maximum of 28 KV, grounded neutral, and at a maximum conductor temperature of 85 C. For use in wet locations varnished cambric cables must be covered with a lead sheath.

Impregnated paper-insulated, lead-covered cables are suitable for operation at voltages up to 69 KV at a maximum temperature of 85 C. Gas or oil filled paper insulated cables are suitable for higher voltage services at somewhat reduced temperatures.

Insulation thicknesses for all insulations depend on the rated voltage, the conductor size and type of insulation. Minimum insulation resistance and test voltages have been established for all classifications.

For reprints of these pages write to address below.

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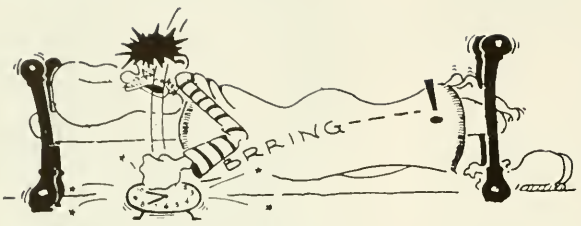

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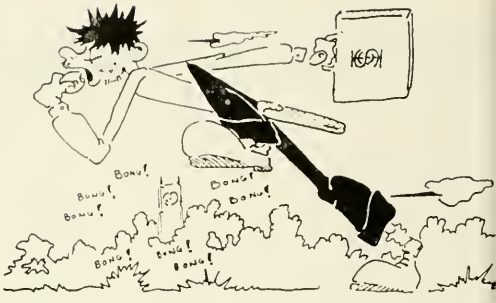

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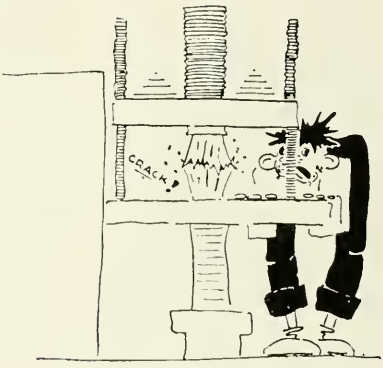
A Day in the Life

12 Noon



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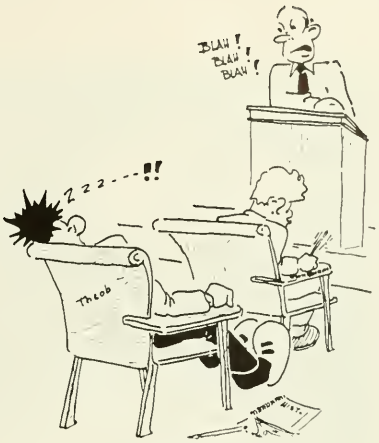

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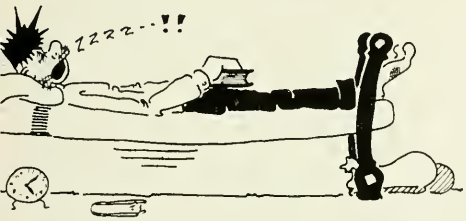
...f an Engineer

• by Ted Boller, Arch. Jr.



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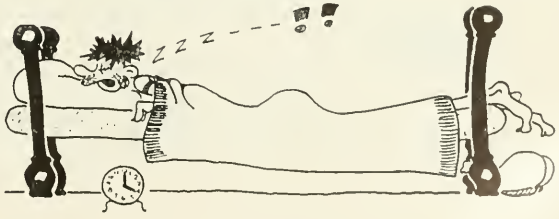

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● Claud M. Kellett, Jr. received his Bachelor of Electrical Engineering degree from Georgia Tech in 1950.

Claud's first year at Allison was spent in the company of other recent engineering graduates in a college graduate training program. This program helped him gain practical experience in the activities of selected departments throughout the Allison plants. On the completion of his training, a call to active duty with the Army delayed Claud's permanent assignment to an Allison department. However, the twenty-one months he was away did not diminish his opportunities in the least. When he returned early this year he was able to resume his career in engineering with the result that today he is an experimental engineer concerned with electronic instrumentation in the Research Group of the Transmission Test Department.

The torqmatic converter turbine that Claud is working with is a vital element in the operation of Allison heavy duty transmissions. Allison is the world's largest manufacturer of torqmatic drives for heavy duty Ordnance and commercial vehicles and equipment. The commercial converters and transmissions are used in scrapers, tractors, trucks, cranes, shovels and drilling rigs.

The problem presented to him in connection with the turbine was to find the level of residual stresses created in the turbine by repair welding performed on the hub. The feasibility of such welds might then be determined. Claud applied variable resistance type strain gages to the turbine vanes at their exits and read their strain levels with the strain indicator. Then he cut the vanes around each of the strain gages to relieve residual stress and re-read the strain levels. From the difference in strain between the stressed and relieved conditions he was able to calculate the residual stress induced by the welds.

Yesterday Claud was interested in torsional vibration and the electronic "know-how" required to present it for oscillographic recording. He knows that tomorrow the many tests of transmissions and component parts will each present unique problems. Pressure transducers, vibration pick-ups electronic flow meters and tachometers must be installed with a myriad of complicating factors ever present. Equipment not available must be designed and built, or existing equipment modified. A future at Allison holds a constant challenge of doing that which has not been done before.

Allison is looking for young men with degrees in **MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING, AERONAUTICAL ENGINEERING** *and* **INDUSTRIAL ENGINEERING.** *There are also a number of openings for majors in Metallurgy, Electronics, Mathematics and Physics.* Write now for further information: R. G. Greenwood, Engineering College Contact, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.

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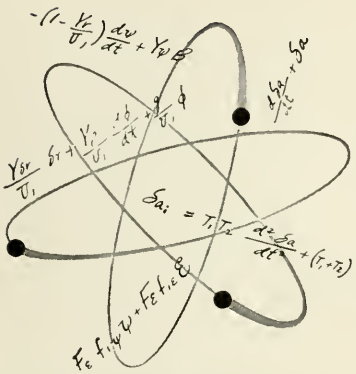

As science advances, and as our country continues to develop its industrial might, the business of automatic control gets bigger and increasingly important.

For the prime force behind the 20th century revolution has been and will continue to be *automatic control.*

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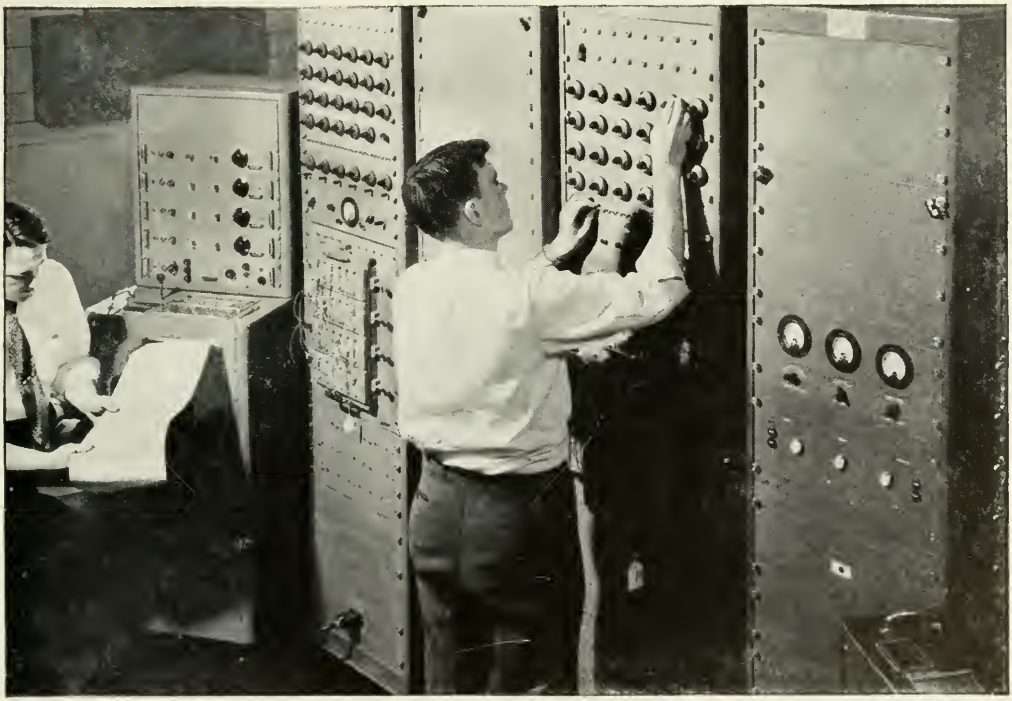
And that's why we're always looking for men with ideas and ambition to grow with us.

Here at Honeywell one out of ten employees is engaged in research and engineering activities.

Shown below is part of our Aeronautical Division's analog computing equipment, which helps our research engineers to develop and simulate flight tests on automatic controls for aircraft. It's typical of work being done by all of the company's eight divisions in plants across the country.

So if you're an engineer or scientist and like to use your imagination freely in such fields as electronics, hydraulics, mechanics, chemistry, physics, and a wide variety of others, be sure to send in the coupon below.



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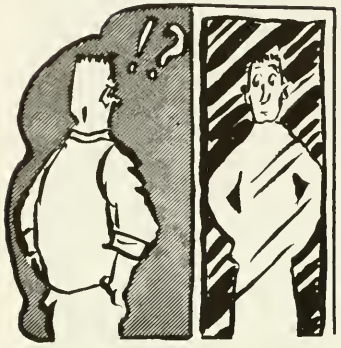
The Need for More . . .



BROAD-MINDED ENGINEERS

by Ken Gablin, E. Physics, '54 (U. S. Army)

In our day of specialists and specialties, we seem to be going through a different trend in the engineering profession. Industry is crying for well rounded men, men that have been trained in all phases of industry, particularly in the fields of engineering, manufacturing and marketing. This trend is reflected in our colleges and universities where pressure is being exerted by the larger corporations to give the engineering students five years of training instead of the usual four. This extra year and additional expense is not to give the student more theoretical work. No, on the contrary, it is primarily designed to give the future graduate a better perspective of the world that he is about to go out into for a livelihood. This additional year is one in which the student can "dabble" in the arts, learn to write business letters, or do anything outside of his college or option to gather valuable training which would be rather difficult for the average engineer to obtain after graduation.

You say the industry wants this? Yes, the industry wants a man who is able to see the whole system; how the raw materials come into the plant, then made or fabricated, and out the back door. The reason is fairly obvious. The day when an engineer entered into the employment of a company and stayed until retirement age at one particular place or type of work is rapidly becoming history. In our modern age of today the engineers are being called upon to do a far more important job. These new positions are executive opportunities in the major functions of modern history. These functions are (1) engineering, the technical work that goes into a product before it is produced in great numbers, (2) manufacturing, the production of the product in such quantities that the unit cost is slight and the consumer is able to buy them, and (3) marketing, the function that handles the distribution of the product from the back door of the factory to the shelves of the retailer.

In the field of engineering lies the research man, then comes the advance and development man, and finally coming down in ever diminishing hair lengths come the design, production and manufacturing engineers. Electrical engineers, mechanical engineers, civil engineers, and general engineers have taken on such prefix titles as systems, product, project, standards, administrative, test, field, and production. What has happened? Simply that the individual engineer can no longer carry all the burdens of the many individual investigations, attend the necessary conferences, and plan the fiscal and field testing programs, and solve the production and packaging problems.

KEN GABLIN, business manager elect for 1953-1954 was drafted during the summer, but submitted this article in absentia. Ken would have graduated in June 1954.

All types are important and have a definite place in industry. The question that now arises in the mind of the young graduate engineer is: Where should I go? The answer is simple. While trying the other colleges to see what they have to offer, you discover that you have aptitudes and abilities in unrelated fields. You then have more than one slot in which to enter. If you take to law, patent law may be the field. Maybe you will like marketing. Why not try engineering sales? The field is wide open and pay is excellent. You say you like journalism. Well you are set. Technical writing is growing into a new profession which requires an engineering background with an unlimited opportunity to learn. It is possible that statistics may get you worked up. Statistical quality control is just breaking the ground.

It is not too important that your first choice is your best either. With

the present shortage of all types of engineers, you have bargaining power in excess of any previous period during the existence of the profession. This will offer you many opportunities to move lateraly between divisions and departments. The modern concept of personnel management would far rather have you do this than become dissatisfied at your present job or leave the company. Management approves of transfers too because it offers the employees a chance to broaden themselves and therefore be an asset to them.

Many of the larger corporations have sensed the need for trained men and have introduced training programs which will enable the graduate to span the gap between school and industry, and at the same time have an opportunity to look around inside the company for the job that he would like to have. Some of the most famous ones are the General Electric Test Engineering Program, The Bethlehem Steel's Loop Course, and Goodyear's Flying Squadron. It is often profitable for the engineer to enter these training programs even though the wages offered are lower. During your lifetime, the benefits obtained from these training programs will far out-weigh the decreased initial wage.

In closing, I would like to point out two important things. Get plenty of training and be flexible. Remember it is just as easy to score a touchdown by running end rather than "bucking" through the middle.

An engineer must make frequent contact with a variety of customers as he attempts to solve their engineering problems.

Engineers are often called upon to make detailed estimates of the cost and application of complex equipment.

A profession is something you study years to get into and then spend the rest of your life trying to earn enough to get out of.

* * *

A yard is only three feet long until a man starts to push a lawn mower on a hot summer afternoon.

* * *

The young are always ready to give their elders the full benefit of their inexperience.

* * *

Most women want to hear the truth —no matter how flattering it is.

* * *

Judging from the flow of refugees the Iron Curtain is nothing more than a one-way sieve.

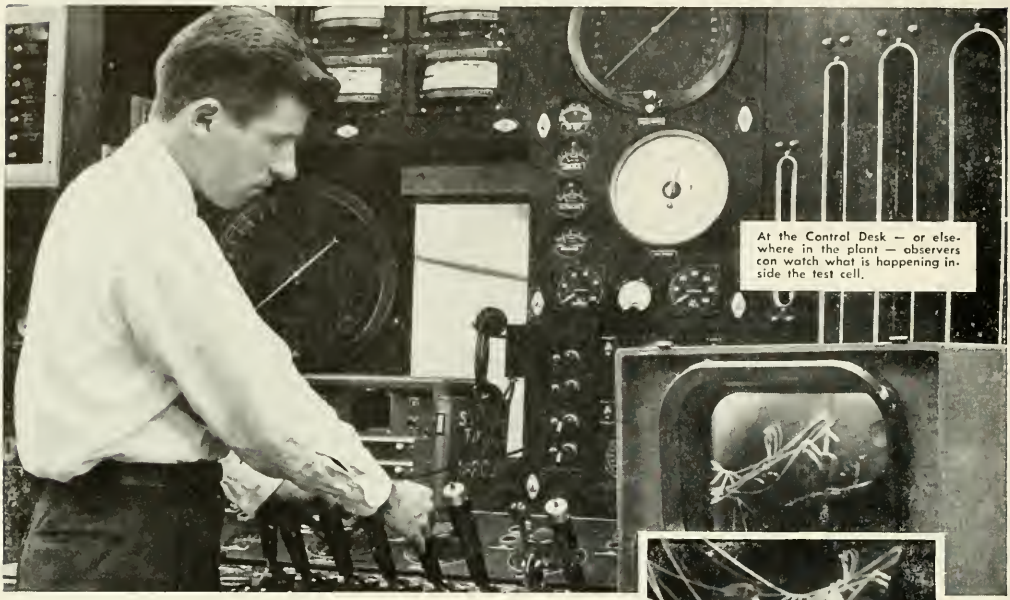
* * *

The woman's work that's never done is most likely the work she asked her husband to do.

* * *

My great concern is not whether you have failed but whether you are content with your failure.

NEW LOOK IN JET ENGINEERING



At the Control Desk — or elsewhere in the plant — observers can watch what is happening inside the test cell.

Television cameras are easily pre-focused on parts formerly impossible to see during a test run.

Through the use of industrial television, Pratt & Whitney Aircraft engineers can now watch what happens as big jet engines are run under abnormal conditions. Without personal hazard, they can see inside the test cell from any location in the plant.

On their television screens they can observe the action of linkages, controls and other parts. Even infra-red characteristics not visible to the human eye can be studied.

But to do this, many technical problems had to be solved. For instance, commercial equipment had to be modified in many ways to operate under abnormal temperatures and in hazardous atmospheres. Soon a further development will permit remote traversing of the camera and adjustment of lenses.

This typifies the way in which new engineering and research facilities are constantly made available to Pratt & Whitney Aircraft engineers. Here engineers are encouraged to experiment with new ideas — given an opportunity to do *real* engineering.

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If you are interested in our employment opportunities for engineers, contact your College Placement Officer or write directly to Mr. Frank W. Powers, Engineering Department, Pratt & Whitney Aircraft, East Hartford, Conn.

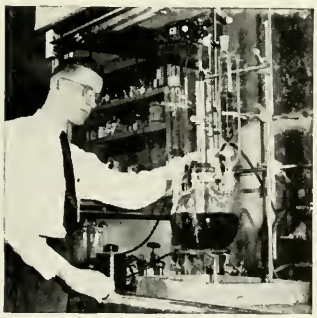
THE DU PONT DIGEST

Research

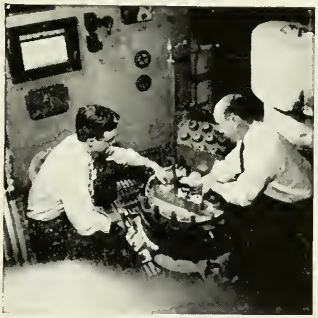
provides broad opportunities for chemists, physicists and engineers cooperating on many problems.

For one thing, much Du Pont research is fundamental, aimed at advancing scientific knowledge regardless of specific commercial objectives. However, such research often suggests new products . . . each with its own challenging technical problems which must be solved before commercial production can begin. Solving these problems offers another great field of work for teams of engineers and scientists.

"Teflon" tetrafluoroethylene resin is an example of this well integrated teamwork.



Howard E. Holmquist, *Ph.D. in Org. Chem., Univ. of Minn. '51, is shown at work on a problem in synthetic organic chemistry.*

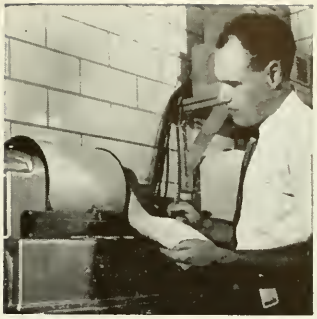


Doing chemical *engineering research on a plate in a distillation tower are: C. M. Gamel, Jr., S.M.Ch.E., M.I.T. '48; and J. B. Jones, M.S.Ch.E., Univ. of Mich. '46.*

During research on refrigerants, the polymer was discovered and work was begun to make it useful. The new plastic had a remarkable combination of properties; temperature resistance beyond the range of any previous plastic, excellent electrical characteristics, and the highest degree of chemical inertness of any commercial plastic.

In fact, "Teflon" was almost too unusual. Although it melts, it is too viscous to flow like other plastics. It does not dissolve—even in aqua regia. There was no method for molding it or for making it into thin coatings.

The problem of molding was solved with the help of techniques used in powder metallurgy. "Teflon" is now molded by cold pressing, followed by sintering or "fusing" at about 360°C.



Research workers *have available modern apparatus, such as the infrared spectrometer being used here by Vaughan C. Chambers, Ph.D. Org. Chem., M.I.T. '50.*

For coatings, previous research suggested dispersions—minute particles suspended in a liquid. After much study, a team of technical men learned how to suspend particles of "Teflon" about 1/125,000 of an inch in diameter. Then a commercial scale process was devised. This development made possible thin coatings of "Teflon" and also a process for extruding the material.

Meanwhile, another group discovered how to successfully formulate the new plastic into "Teflon" tetrafluoroethylene resin finishes and wire enamels.

The development of "Teflon" illustrates the close teamwork that is the basis of research at Du Pont. But this teamwork doesn't end with research. Bringing the product to commercial reality requires development and design work by chemists and both chemical and mechanical engineers. Next month's Digest will feature information on the opportunities Du Pont offers men interested in this phase of making "better things for better living . . . through chemistry."

ASK FOR "Chemical Engineers at Du Pont." New illustrated booklet describes initial assignments, training and paths of promotion. Just send post card to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware. Also available: Du Pont and the College Graduate and Mechanical Engineers at Du Pont.

DU PONT

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

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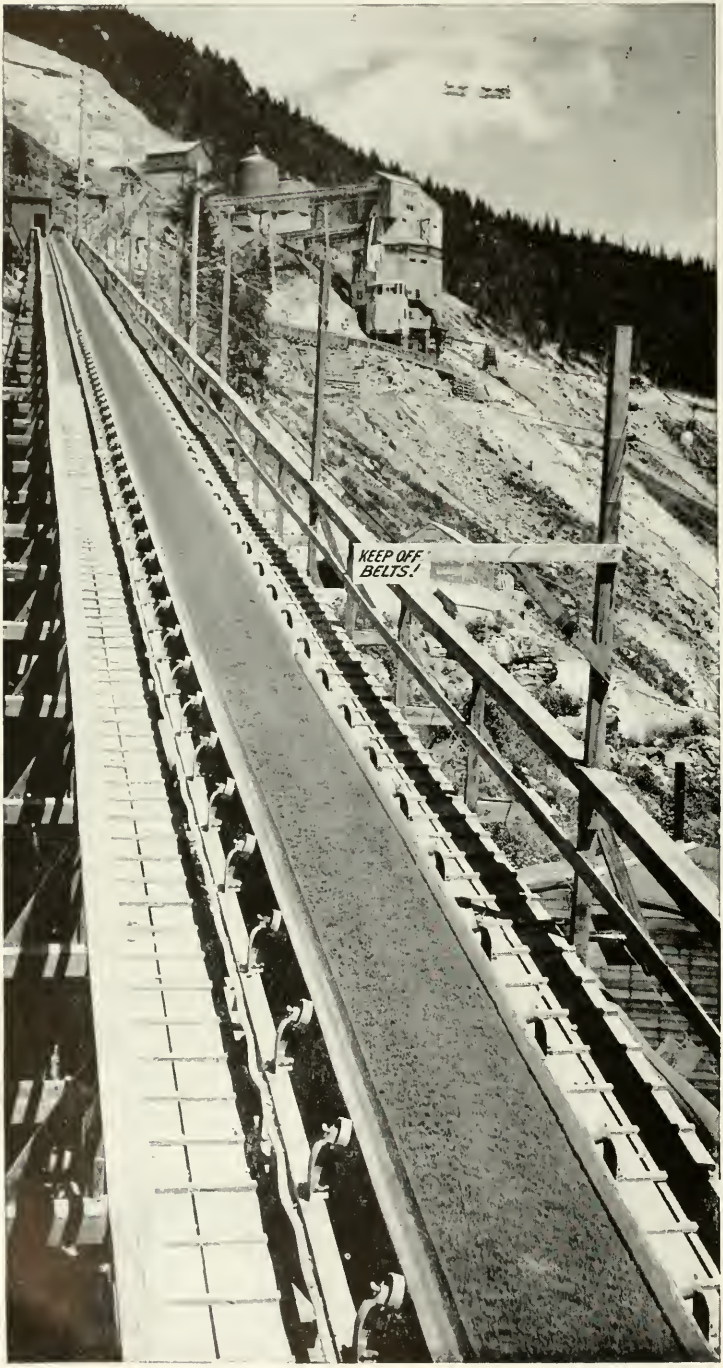
High speed "highway" for low costs



Millions of tons of bulk materials now ride on belt conveyors engineered and built by LINK-BELT

For bulk materials handling, belt conveyors provide remarkable initial economies. And in many cases operation and maintenance cost far less than any other method of transportation.

Belt conveyors handle huge tonnages, because the material runs at high speed in a continuous stream—24 hours a day, if desired.

Initial cost is low, because there is no need to carve out hills or fill in low spots —no need for heavy bridges over obstructions. Belt conveyors are light in weight and operate in narrow or low passages . . . up or down steep grades. They are inherently long-lived, requiring little maintenance.

The science of handling bulk materials is just one of many growing fields open to graduate engineers at Link-Belt. If you're near one of the many Link-Belt plants listed below, stop in for a talk. Or write today for fully illustrated booklet, "An Introduction to Link-Belt."

◀ *Link-Belt belt conveyor system at Hungry Horse Dam (Mont.) carries 900 tons per hour of blended sand and sized aggregates up a steep canyon wall to concrete mixing towers.*

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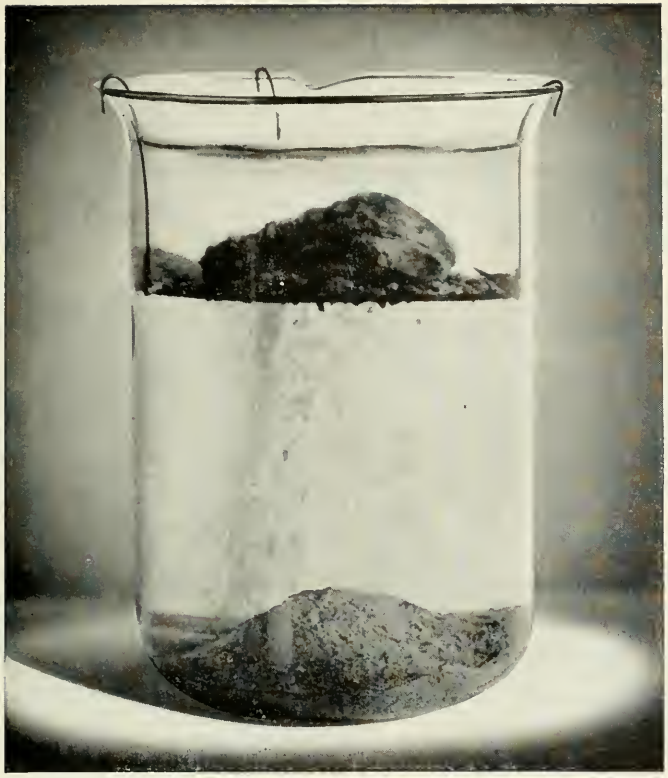

DEMONSTRATION . . . By a Norton-developed process, "32" ALUNDUM abrasive grains form in an electric furnace in a fluid mass. Each grain "grows" into a single crystal. As the matrix dissolves, the crystals are released — each one complete in itself, strong, hard and with many sharp points. No crushing is necessary.

TOOL GRINDING with a Norton ALUNDUM wheel is rapid . . . gives operators the "Touch of Gold" by better and more economical tool sharpening.

Dramatic step in giving grinding operators the

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"32" ALUNDUM, a Norton development in abrasives*

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This is one of the ways we at Norton carry out the tradition of "Making better products to make other products better." Another is in the field of Special Refractories where Norton catalyst supports, seamless porous mediums, kiln furniture and furnace linings are helping industrial progress.

A career at Norton where engineers and technicians work in 19 specialized areas, would be interesting and productive. But wherever you work, bear in mind that Norton is the world's largest source of abrasives and abrasive products. For information write NORTON COMPANY, Worcester 6, Mass.

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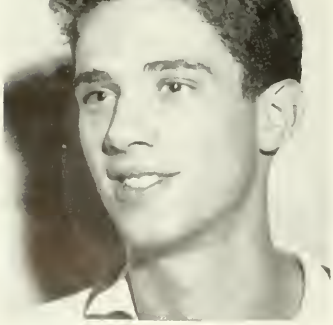
by Ken Gablin, E. Physics, '54 (U. S. Army) and
Donna Rudig, E. Physics, '57

MARTIN GOLDSTEIN

As this is the first issue of the *Technograph* for the '53-54 school year, it is only right that we should present an old newspaper hound, our editor, Marty Goldstein.

Marty is a native of University City, a suburb of St. Louis. While still attending high school he became distinguished for writing, at least in his home town. This happened when, as feature editor of his school newspaper, he won an award by writing an article in a National Tuberculosis Association contest.

Having such a journalistic background it's no wonder Marty's favorite hobby is the *Technograph*, which fills most of his spare moments. He is also an avid fan of that brain child of modern writing, science fiction. His other hobbies are girls (which he declares he will give up) and photography.



Hobbies aren't enough for Marty; he's also in many campus activities with an emphasis on engineering. The Praetorian social fraternity is proud to claim him as a member, and so is Pershing Rifles, which he joined in February of '52. He belong to the ranks of AIChE and has participated in two Engineering Open Houses. For the '52 Open House he was lunch stand sub-chairman, and in '53 was the physical arrangements chairman. To top things off he held the office of social chairman for Clark House.

This junior Chem E major is really in love with the U. of I. for he turned down a $600 scholarship to the Illinois Institute of Technology in favor of the Illini. During his busy two years on the campus, Marty has maintained a 4.0 average and expects to graduate in June of '55 with a B.S. in Chem E. After a stint in the army he hopes to obtain an administrative position with some organization. We feel that if he continues to maintain the high caliber of work he has done here at Illinois, his success is assured.

PROFESSOR JOHN "JACK" HENRY

Since the ECMA National Convention is being held at the University of Illinois this fall, it is only fitting that we, the staff of the ILLINOIS TECHNOGRAPH, introduce our favorite son. He is Professor John Henry, who is known as "Jack" among his faculty friends. Prof. Henry has always been active with the staff since he came to the University of Illinois and during the two years of 1947 and 1948, he served as president of Engineering College Magazine Association.

His early life was spent in Chicago and in Royal Oak, Michigan, where he received his boyhood education. Upon graduation from high school, Jack entered Michigan State College and emerged in 1930 with his BS in Mechanical Engineering. It is easy to see that he was not wasting his time at Michigan State after learning that he is a member of Tau Beta Pi Engineering Honorary, Pi Tau Sigma Mechanical Engineering Honorary and Phi

Kappa Phi All College Fraternity. During 1941, Professor Henry, with his wife and children came to the University of Illinois to do additional work in Mechanical Engineering. He received his MS in Mechanical Engineering in 1945.

His duties at the University are divided between heat power laboratory, the Student Counseling Bureau, and his favorite course, quality control. Professor Henry's main form of expression comes from teaching statistical quality control and is reflected by his accomplishments in the field. He is one of the founding members of The American Society for Quality Control, and at present is chairman of the Committee on Education and Training. Jack has been active in some 15 to 20 short courses and does active consultant work in the field.

With all his outside activities, Professor Henry still finds time to serve his local Boy Scout Council as chairman of the training committee and spend one-fourth of his University time at the Student Counseling Bureau.

From his experiences with the Counseling Bureau, Professor Henry would like to see the state of Illinois establish two year technical schools similar to the ones in New York and Oklahoma for persons with technical apptitudes but not the abilities to enter into the engineering profession.

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EC53-6

High Speed Electronic Memory

edited by Paul E. LaViolette, E. E., '55

Successful experimental operation of a very high-speed electronic memory device that promises to help solve scientific and economic problems too vast and too complex for the present capabilities of electronic computers has been revealed by Dr. Jan A. Rajchman, a physicist of the RCA Laboratories Division.

The new memory device, which combines the feature of high speed with a potentially huge information storage capacity, was described by Dr. Rajchman at a recent symposium on digital computers sponsored by the Argonne National Laboratory at Lemont, Ill. Designed at the David Sarnoff Research Center of RCA, Princeton, N. J., the device consists basically of 10,000 tiny ring-shaped magnets woven on thin wires.

The memory section is often considered the weakest link in present-day computers, Dr. Rajchman said. Various memory systems now in use are either fast in receiving and giving out information or they can store vast quantities of information, but none has been able to do both. Besides, he said, many systems are not completely reliable, i.e., they tend to "forget" or "scramble" some of the information they have stored before it is wanted by the parts of the computer that do the actual computing.

Dr. Rajchman said the new device appeared to offer significant advantages for computers of the future because:

1. It can "memorize" or "recall" a bit of information in a few millionths of a second. (A bit of information is expressed as "0" or "1" in a computer. In combination with other bits, it can represent numbers or words or symbols).

2. It can store 10,000 bits at any one instant. With 100 such devices connected together, which is theoretically possible, a million bits could be stored. A million bits is more than would be needed to translate five solid pages of a newspaper into the memory's language.

3. It potentially has a very high degree of reliability, since its tiny magnetic cores never wear out no matter how much information is fed in or out. Besides, a core could hold the same bit of information for years, if this were desired.

4. It promises to be relatively cheap, as memories for computers go.

The heart of the present 10,000-core memory, Dr. Rajchman explained, is a grid or matrix of a hundred closely spaced wires at right angles to which run a hundred more wires.

At each intersection of the wires is a magnetic core, he said. Through the center of each core runs one vertical wire and one horizontal wire.

The cores, which are about the size and shape of the type-written letter "o" and one-fifteenth of an inch thick, are made of a special ferromagnetic spinel, a ceramic-like material. This special magnetic material, which is easily molded on automatic machines, was developed by RCA Laboratories Division along with equipment for rapidly stamping and testing the individual cores.

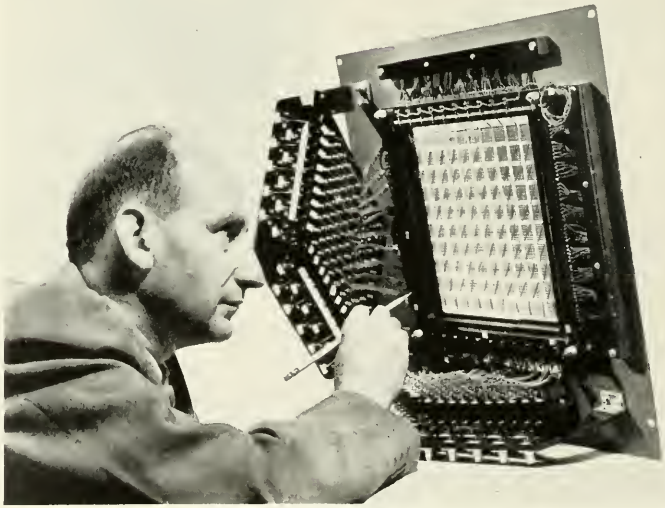
The magnetic material of the cores is such that when there is an electric current of a certain intensity flowing through the two intersecting wires a core will switch its magnetic polarity from positive to negative, or negative to positive, depending upon the direction of the current.

Current of the same intensity in one wire alone is not enough to trip the polarity. Thus only when currents are flowing in both wires, will the core at their intersection flip into opposite polarity (if it is not in that state already) causing the core to "memorize" one bit of information.

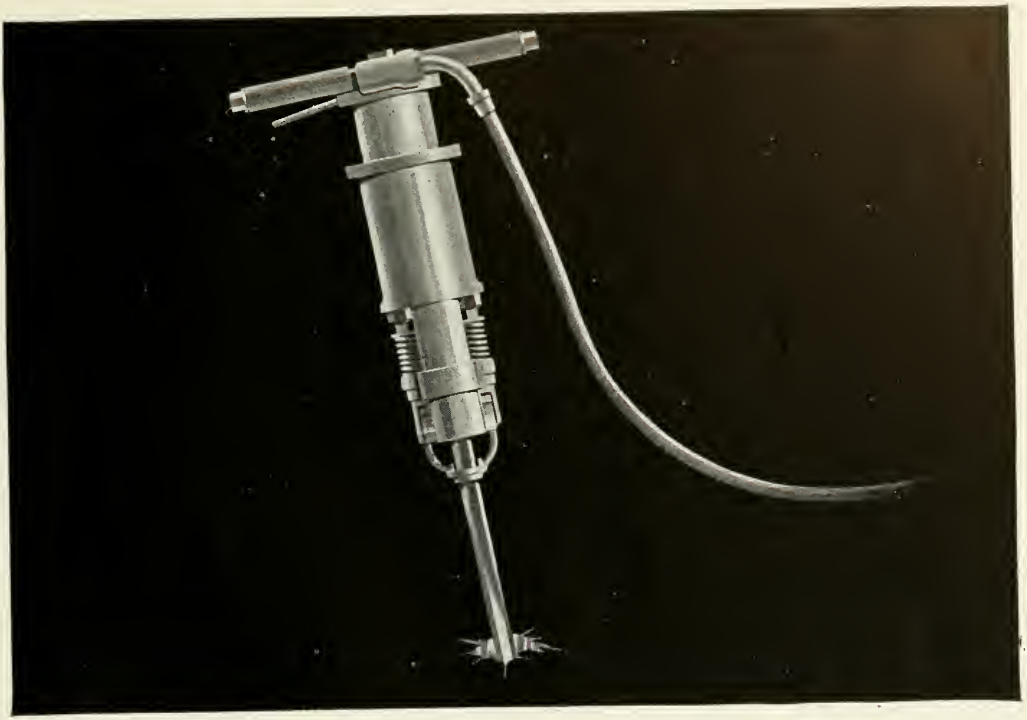
Thus by applying a current to a particular horizontal wire and a particular vertical wire only the core at their intersection may be tripped.

Recalling, or reading out, information from the memory is also accomplished by operating on one core at a time. The operation is so fast that a hundred thousand bits can be withdrawn in a second.

The core to be interrogated is subjected to pulses along its two intersecting wires. If the core is tripped into opposite polarity, its reversal of polarity creates an electrical signal in a wire that runs through the center of all 10,000 cores. If it is not tripped, no signal appears in the common wire. In either case, the nature of the bit of information it contains is determined. (if the core is tripped in reading out, it is automatically returned to its original state



Dr. Jan A. Rajchman, RCA physicist, examines the 10,000 tiny magnetic cores that "memorize" in a few millionths of a second information used in electronic computers.



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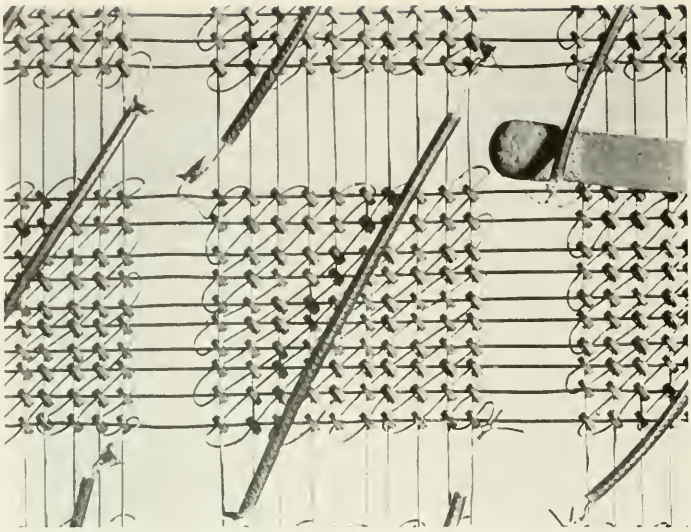

Enlarged view of a section of a new magnetic memory device developed by Dr. Jon A. Rajchman. (Photos courtesy of RCA)

by associated circuits; thus, no permanent erasure of information need take place.)

The basic principles behind the new device, which is formally called the "Myriabit Magnetic Core Matrix Memory," were incorporated in an earlier experimental memory completed by Dr. Rajchman last year which had sixteen horizontal and vertical wires, thus a storage capacity of 256 bits. In summarizing the progress his research group has made since, he said:

"Ferrospinel magnetic materials with rectangular hysteresis loops were developed in the middle of last year. By the use of automatic molding and testing machines it became practical to envisage memories with capacities in tens of thousands of bits. The basic problems in the realization of such memories are the switching and read-out methods by which fast random access can be obtained efficiently. Successful solutions to these problems are demonstrated in the experimental 10,000 bit memory reported in this paper.

"Last year, on the basis of a memory with 256 bits, we predicted that in the near future storage capacities of thousands or tens of thousands would be achieved and capacities of millions in a more distant future. As the first part of this prediction is now realized we venture to reiterate the second. Of course, this will require great innovations in construction techniques and still further improvements in magnetic switching. But we have no doubt that memories in which random access to millions of information bits in a few micro-seconds will be available at a relatively low cost.

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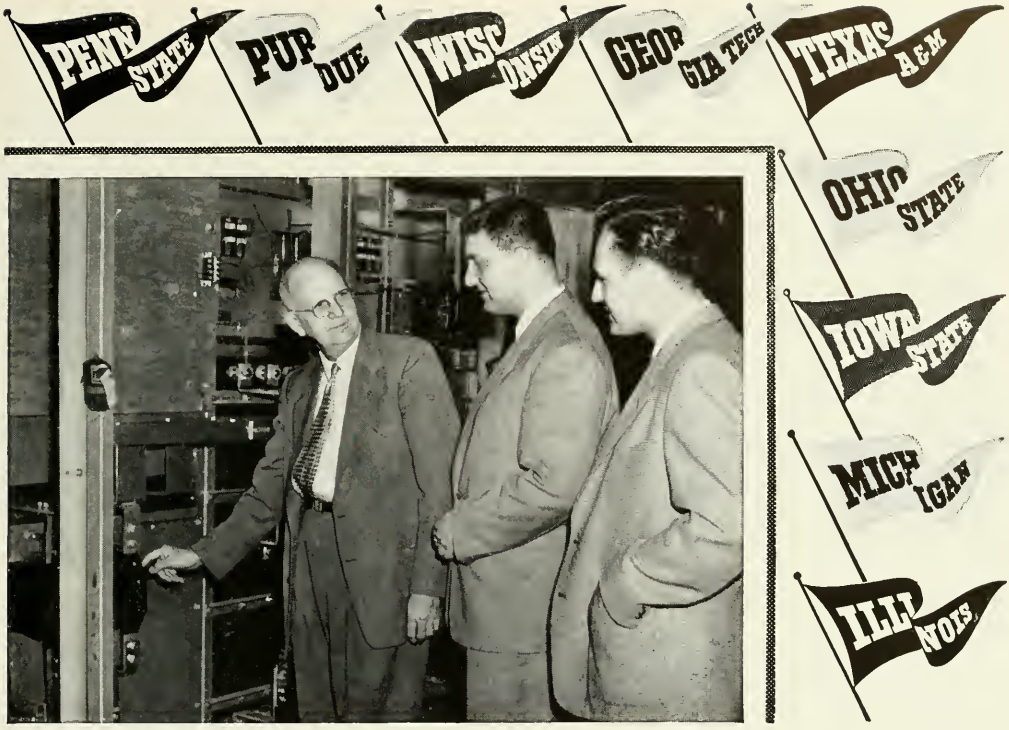

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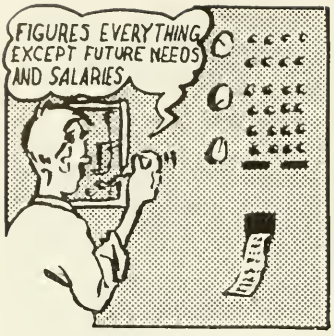

Future Demands in Engineering

by S. H. Pierce, Associate Dean, College of Engineering, and
W. E. Miller, Assistant Dean, College of Engineering

During the past several years there has been an ever-increasing demand for engineers, physicists, chemists and other scientifically trained personnel, while during the same period the number of graduates in these scientific fields has been steadily decreasing.

This demand for engineering talent is not merely the result of a post-war boom, but rather stems from a combination of many deep-seated circumstances permanently coupled to our modern day, mechanically minded, society. Much has been written and spoken about the causes of this situation and its future effects on the life of the nation. Excerpts from the writings and addresses of some of the best informed analysts of the current situation follow.

Mr. Carey H. Brown, chairman, engineering Manpower Commission, states: "The increasing complexity of our industry and the development of new technological areas such as atomic energy, antibiotics, jet propulsion, electronics, etc., have caused a definite upturn in the use of engineers and scientists quite independent of military mobilization. The ratio of engineers to direct labor has been increasing steadily since 1890. It now stands (in 1951) at about 1600 engineers per 100,000 workers, according to the Bureau of Labor Statistics and there is no sign yet that the relationship has commenced to level off.

"A survey in June, 1951 of the needs of 378 companies and governmental agencies shows that about 80,000 engineers are needed now exclusive of the needs of the military. The urgent need for engineers cannot be met through the current sources of supply."

Dr. S. C. Hollister, Dean of Engineering, Cornell University, writes: "During the past 50 years our population has doubled. Our production, however, has increased four and three-quarters times what it was at the turn of the century. Not only has the engineer made possible this increase in production, he has had profound influence upon transportation and communication as well.

"It is expected that our population in the next 25 years will increase by 20%. This will affect what is needed to maintain the basic economy at a reasonable level. In addition, we will have continuing commitments abroad which must be cared for, where in many places rising populations menace the economic balance.

"The present status of engineering manpower is so critical in the nation's welfare and security that every means available should be utilized to make adequate preparation for the future.

"There is a wholly inadequate supply of engineering graduates to meet the ultra-conservative estimate of the need of 39,000 per annum. The best efforts at increasing interest of high school graduates may add 4,000 to 5,000 to the annual graduates in engineering, but not before 1956. With the addition of 5,000 in 1956 the total number of graduates would only be 22,000.

"There will not be enough graduates from 1953 to at least 1961 to meet the peacetime need as conservatively estimated by the Bureau of Labor Statistics, at 30,000 per year, the shortage being at least 20%.

"Whatever the military requirements for engineers may be, they are not available except by taking men from industry, thus further intensifying the needs of industry. The first step toward bringing need and supply toward better agreement will be to change the pattern of utilization through spreading the engineer's work over a greater range and thereby lessening the need. In any case, it does not appear that by any present or likely pattern of utilization or available source of supply, the need and supply will be brought into balance over the next decade."

The increasing demand for engineering graduates is directly reflected in the number of industrial companies who have visited our College of Engineering to interview our students over the past three year period as shown in the following table.

In addition to the expansion of industry, the critical shortage of engineers has been aggravated greatly by such factors as the low birth rate of the 1930-1937 era, demands of Selective Service, and lack of correct public information regarding the engineering profession.

Individual calls received from companies who did not visit our campus over and above those represented by the above figures have likewise increased tremendously.

From the following enrollment figures of our College of Engineering, including the Navy Pier Branch, as well as the total enrollment of the 149 engineering colleges accredited by the Engineer's Council for Professional Development, it appears that the supply of engineering graduates will not increase appreciably until 1956.

	Enrollment in the College of Engineering, University of Illinois as of October, 1952	Total Enrollment of 149 Engineering Colleges Accredited by E.C.P.D. as of October, 1952
Freshman	1,460	45,854
Sophomore	652	26,636
Junior	450	22,369
Senior	445	23,453

While the future for engineering graduates appears very promising, let us inject a word of warning in closing. The road to becoming an engineer is a rough one requiring many years of strenuous study. Even after graduation the engineer finds sharp competition in all fields of engineering endeavor requiring continued study. Let us, therefore, enter the pursuit of an engineering education with enthusiasm, vowing to do the very best job possible at all times.

School Year	Number of Company Visits	Number of Student Interviews	Aver. No. Interviews per Company Day	Companies Cancelled Because of Lack of Available Students	No. of Students Graduating at B. S. Level
1950-51	264	3,031	15.2	not available	849
1951-52	391	5,618	11.5	47	486
1952-53	427	5,410	11.2	92	459

THE BEST YEARS of his life are not all past for Tom Toman (left) of Casper, Wyoming. Tom retired over five years ago after 26 years with Standard Oil. He's here shown fishing on the North Platte River, with his son, Rudy, now one of our employees at Casper. Every month Tom receives retirement income provided through his and the company's contributions to Standard Oil's retirement plan while he was working.

TESTED WAYS TO BETTER LIVING

BETTER LIVING can begin with your job. The fact that 19,900 employees of Standard Oil and its subsidiary companies have been with us for more than 10 years is evidence of that.

What do all these people find in their jobs that keeps them happy?

Steady work at good pay comes first to mind. But in addition to being assured of better-than-average earnings with a growing and progressive company, Standard Oilers can work with the company toward security for themselves and their families. Employee benefits have been steadily improved since the company's first retirement checks were mailed to Standard Oilers in 1903. Our present retirement plan, in which more than 90% of our eligible employees participate, is part of one of the broadest employee benefit programs in any industry.

These benefits help guard against financial stress in case of accident—on or off the job—or sickness, and bring such things as hospitalization, regular savings, and stock ownership more easily within reach.

Every job here is important in some way to every other job, too—so that all our 51,000 employees, pulling together, help make Standard Oil an even better place to work.

Finally, when you know that your efforts are important to your community and to your country, you can feel you not only make a good living, but you're living well.

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DADDY'S PROUD—and relieved. Melvin Long of our Champaign, Illinois, bulk plant paid a large part of the expenses of daughter Patricia Ann's arrival through Standard Oil's contributory Group Hospital Expense and Surgical Operation Insurance Plan, which covers employees and their immediate families.

IT'S NO FUN TO BE SICK—but Lydia Wagener and her visitor, Sophie Szkarlat, both of our Detroit office, know she is protected under Standard's Sickness and Disability Benefits Plan, and its Occupational Illness and Injury Plan. Employees receive substantial payments in emergencies caused by sickness or injury either on or off the job.

SAVINGS PAY OFF double at Standard Oil. Catherine Lynch and Elizabeth Faller help issue bonus stock certificates. Under our Savings and Stock Bonus Plan, 29,410 employees have bought U. S. Savings Bonds and received, in turn, shares of company stock at no cost to become stockholder-owners of Standard Oil.

Atomic Power Generation

by Howie Hadler, Ag. E., '55

North American Aviation has designed an atomic power generator and is ready to build a pilot plant to demonstrate and study the production of electrical power for industrial and domestic uses. An estimate of the cost of such a pilot plant is $10,000,000.

The nuclear reactor designed specifically to produce electricity was developed under contract with the Atomic Energy Commission.

Certain phases of the design are classified as restricted data under the Atomic Energy Act. The plans are available for inspection through the commission by all persons and concerns cleared for access to restricted data.

A scale model of the pilot plant, complete with flashing lights, moving control rods and clicking Geiger counter, was exhibited as an example of the atomic central power plant of the future. The model was built in the company's research laboratories at Downey, California.

The purpose of the pilot plant would be to demonstrate and study the practical and economical aspects of electrical power production by a nuclear reactor of this specific design.

"It is expected," said J. L. Atwood, company president, "that research and experience with the pilot plant will result in the future design of a larger atomic energy reactor to produce electricity on the same scale as conventional central station electrical power plants using ordinary fuel or water power."

The proposed pilot plant would generate about 8,000 kilowatts of electrical power, enough to supply 2,000 average homes with electricity. This power could be utilized for other atomic energy research to be done at the site of reactor.

Dr. Chauncey Starr describes the scale model of a proposed pilat plant for generation of electrical energy. Looking on are J. L. Atwood, president of North American Aviation, and J. H. Kindelberger. (Photos courtesy of North American Air Lines)

Electrical power will be generated in the pilot plant from the tremendous quantity of heat produced by the atomic fission process. This heat will be absorbed by a liquid metal passing through the reactor and will be piped into an ordinary water boiler to produce steam. The steam would then be used to drive a turbine generator combination such as those used by conventional power plants to produce electricity.

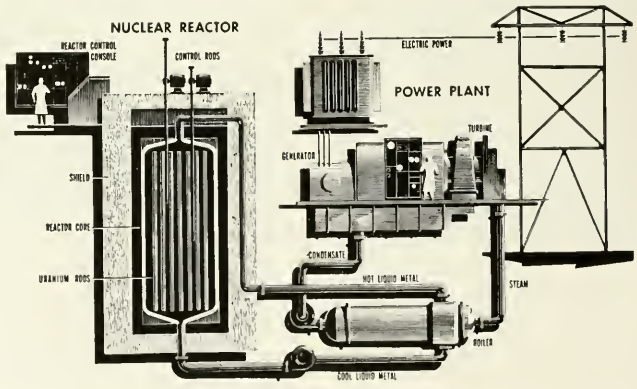
Externally, the pilot plant would resemble an ordinary electrical power plant, except for lack of coal, oil, or other similar fuel handling equipment. Unlike the present conventional installations, there would be no smoke or fumes.

Engineering for construction of such an atomic plant could begin immediately, with full operation expected in about two years.

Although additional scientists and engineers would be necessary to conduct special research and investigation, routine operation of the pilot plant would require no more operating personnel than a conventional plant of the same capacity and would be equally safe to operate. Safety would be achieved through the built-in characteristics of the design and by use of special control devices.

While the cost of producing electricity from atomic fission is at present higher than the conventional methods, through research with such a pilot plant more nearly competitive methods of power production from atomic energy are expected to be developed. In areas where fuels such as coal, oil, gas and water power are not economically available, atomic power plants would have a distinct advantage over conventional installations.

As an example of the amount of power obtainable from atomic energy, the fission, or "burning," of one pound of fissionable material, such as uranium, is roughly equivalent to the burning of 1,500 tons of coal. By burning 10 pounds of fissionable material a day in a reactor power plant, electrical power equal to the ultimate capacity of Hoover Dam can be produced.



Midget with the giant brain

The Problem

To design and build a computer for airborne automatic control systems—with severe restrictions imposed on size, weight and operation under extreme environmental conditions; in short, a computer that would be small, simple, reliable, rugged—and easy to build and maintain.

AT HUGHES RESEARCH and Development Laboratories this problem was examined exhaustively, and it was concluded that a digital computer offered the best means for satisfying the requirements because of its ability to solve complex problems accurately and quickly.

Because the requirements of this application could not be met by existing digital computers, owing to their large size, the following developments were undertaken:

1. Simplification of the logical structure of the computer through the use of a mathematical theory of computer design based on Boolean algebra—but with retention of the operational versatility of a general-purpose computer.

2. Development of ingenious circuitry to utilize the new logical designs.

3. Achievement of minimum size by the use of subminiature techniques, including germanium diodes, subminiature tubes, and etched circuits.

4. Employment of unitized construction: plug-in units of flip-flop circuits and diode networks.

Need for subminiaturization, then, was a governing factor. Consequently, entire new techniques for making things not only vastly smaller, but at the same time easier to build and service, were developed by Hughes. This is a continuing process and there is indication of even more significant advancement in miniaturization for the future.

A major effort at Hughes is also devoted to adapting electronic digital computer techniques to business data processing and related applications—destined for far-reaching peacetime uses.

One of the subminiature switching circuits from the Hughes airborne electronic digital computer is examined by Dr. Eugene M. Grabbe (right), Associate Head, Computer Systems Department, Advanced Electronics Laboratory, and Phil A. Adamson of the Technical Staff, Radar Laboratory.

ENGINEERS AND PHYSICISTS

Activities at Hughes in the computer field are creating some new positions in the Laboratories. Experience in the design and application of electronic digital computers is desirable, but not essential. Engineers and physicists with backgrounds of component development or system engineering are invited to apply.

ADDRESS: *Scientific and Engineering Staff*

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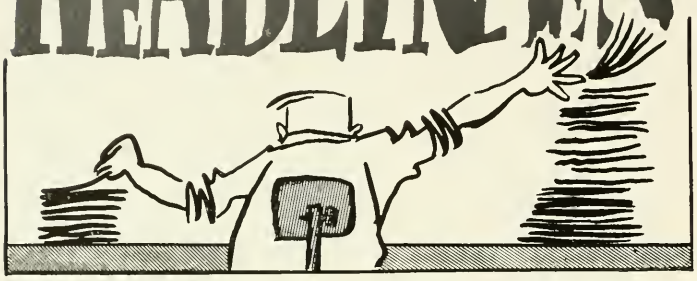


edited by Tom Brody, M. E., '56

By 1956, the first all gas turbine seagoing commercial vessel, a tanker for British Shell Oil, will slide down the ways.

Army vehicles powered by gas turbines are undergoing road tests. The Air Force and Navy have gas turbine-powered electric generators, pumps, space heaters, and air coolers.

In regular freight service from General Electric is a 4,500 H. P. engine, which is undergoing tests for use as a locomotive power plant. Larger units have been built up to 27,000 K. W. These units have been built for Central Station power generation. The largest unit of this type is in Europe.

Units of fifty horse-power and lower are big producers commercially and are readily available for numerous uses from fire-fighting to helicopters and boats.

Fast spreading industrial use of electronic equipment was highlighted this month by the opening of Du Mont's Instrument Division, Clifton, New Jersey. It was pointed out that the cathode ray oscillograph is one of the most flexible and versatile measuring and indication devices. Almost any form of energy, light, sound, heat, radio waves, and mechanical force or motion, can be transformed into electrical energy and its variations examined on a cathode ray screen. Today, cathode-ray ocillographs are not only used in connection with television, radar, guided missals, and atomic energy but also for such everyday jobs as studying the acoustics of buildings, the elasticity and hardness of metals, the colors of paints and textiles, the performance of steam engines, and the chemical structure of molecules. These are good examples of how many industries are putting a technical development to work.

A balancing machine has been developed that will detect displacements of 0.0004 in from a center of gravity. The Cosa Corporation, New York, claims it can show the amount and location of dynamic and static unbalance in rotating parts weighing from a few ounces to over 100 tons. It uses a watt meter with electrical measuring that uses no electronic tubes or oscileographs.

Caned Motors for driving hot water circulating pumps for nuclear reactors are being developed by Westinghouse Electric Co. The squirrel-cage rotor is contained in a shrunk bit jacket of steel and it turns within a stator that is fully enclosed in stainless steel. The motor and pump are integral and must pass Navy Shock and breakage tests. A small unit has been operating for 13,000 hours under full load conditions.

A recent survey indicates that 40% of the jobs performed by the vaccum tubes in airborne equipment can be replaced by germanium junction type transistors. The U. S. Air Force predicts that such transistors, with components miniaturized to match, could reduce airborne equipment 1/5 in size and 1/4 in weight.

Engineers are studying with a great deal of interest the recent development of a new fire retardant paint that is easily applied by brush or spray and actually stops fire from spreading. Because every drop of this paint is claimed to contain a mass of minute "built-in" fire extinguishers, this oil base paint pours out carbon dioxide and calcium chloride which smothers fire and retards the spread of flame right on the surface.

Continuing studies and research of fire retardant coatings are going ahead in pilot plant production because far more important than preventing property loss is the great savings in human life. The United States Navy is among those showing the keenest interest and offering the largest research progress.

Always a terror filled nightmare to sea-faring men, fire at sea proved a more than adequate impetus for studies many years ago, but World War II, and more recently launching and landing fast flying jets on aircraft carriers supplied the tremendous stimulus for maintaining even greater research into fire protective coatings.

If you are one who worries about women drivers, a Michigan professor has just discovered that the Romans passed a law in 205 B. C. prohibiting women from driving chariots.

* * *

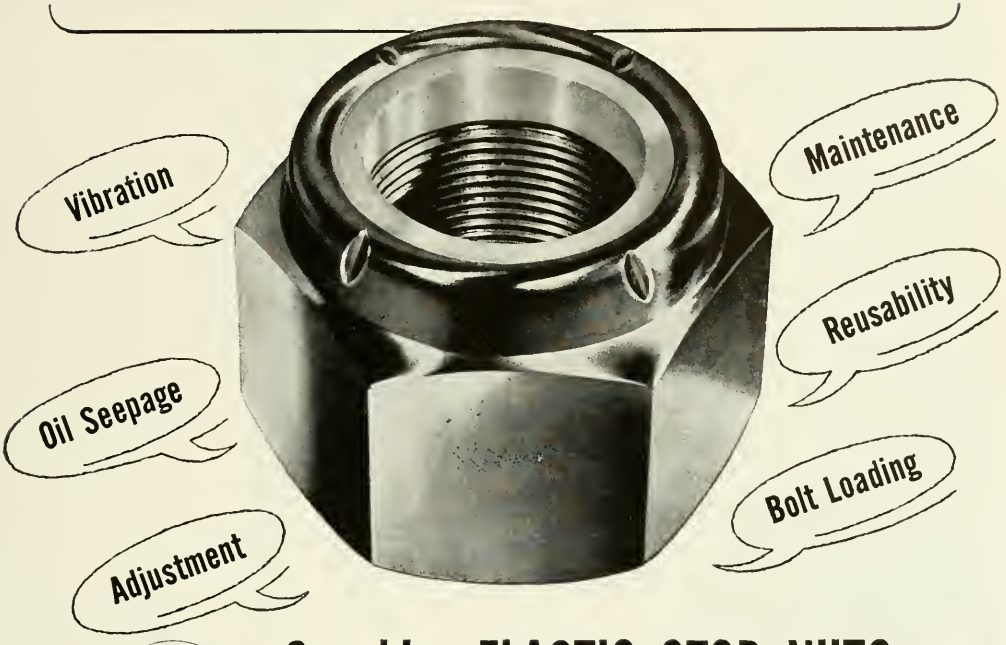
All eyes were on her curves as she approached. Her protruding sheeted hyperbolas were so round, so firm, so fully packed. The parabolic motion of her bilateral posterior knocked my inertia into a spiral of Archimedes.

Her velocity, her lines, her rhomboid rear made me couple and uncouple my digits with an accelerated anxiety. With her straight line was not only indeterminate but a geometrical impossibility.

She was mine, torus, axis, and base, and everything was all square until upkeep began to run me around in cubic curves. I was forced to let her go when I found the second derivative of the money in my prismatic wallet to be zero, but as I stood and watched her move away in simple harmonic motion, I said to myself, "That's the best looking hot rod in town."

(The Auburn Engineer)

Whenever fastening problems arise...



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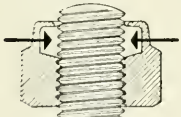

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THE MAN WHO IS HAPPY IN ENGINEERING

by Maurice Garnholz, Aero. E., '56

The way to becoming an engineer is rather lengthy and arduous, as the student and prospective engineer will soon discover for himself. If the reader happens to be an upperclassman, this fact is probably already self-evident. But the rewards and satisfaction obtained by being a member of that large and varied group—the engineering profession—are enough to offset and repay manytold the difficulties, time, and effort expended to alight at the doorstep of industry and applied science. If the person is one who really belongs to the engineering world—in his feelings as well as mental ability and ingenuity—then he will be happy and satisfied, which is everyone's goal in life if he ponders over it awhile.

One may easily ask as to what there is about engineering that will make him content to be one. That is strictly up to the individual's tastes, personality, and interests. Perhaps it would be wise to attempt to define engineering or to classify that human thinking machine with a slide rule. With the aid of a dictionary, one can observe that "engineer" and "ingenuity" come from the

same Latin word, *ingenium*, meaning natural ability or skill. Then in this sense, an engineer is a person who has the natural ability to perform his job ingeniously. Such ingenuity was illustrated by the engineer who, when faced with the problem of stringing a cable through a winding pipe, solved his problem by tying a piece of string to the tail of a cat and coaxing her through the pipe by a blast of air from the end of the pipe. Obviously this type of solution isn't common, but it does show the open-mindedness that an engineer must have when he hunts for an answer to a practical problem.

In the modern professional sense, a better definition is this: Engineering is the art and science by which the properties of nature and the sources of power in nature are made useful to man. In a similar manner, the engineer is defined by these words: An engineer is a person specifically trained and experienced in the use of materials, men, and money so that these forces are put to the service of man.

Because most problems in engineering are complex ones, a precise answer like that obtained in the solution of mathematical problems is usually not possible. This fact has given rise to the familiar "cut and try" or empirical method of the engineer which is embodied in this step.

From this statement of the engineer's methods, one can see that he not only thinks analytically but also works systematically. In fact, it is this organized attack, together with the engineer's mental integrity, which is the outstanding characteristic of engineering. The persons who like to attempt to solve practical problems analytically and systematically, along with those who enjoy using their ingenuity and knowledge, are the ones who get the contentment out of their work. They are happy in what they are doing.

The engineer is a builder, a creator. To be sucessful as a designer and builder he should have first, the desire to create; second, the ability to imagine, or see the completed structure from the plans which he or somebody else has made; third, sufficient initiative to attack a new problem by himself and follow it through to completion without supervision; fourth, the ability to do a piece of work thoroughly and accurately. Those with these aptitudes will find themselves in *their* field if they are in engineering. There is a very definite *how* and *why* in engineering. If one has this scientific curiosity, engineering is an excellent place to satisfy it.

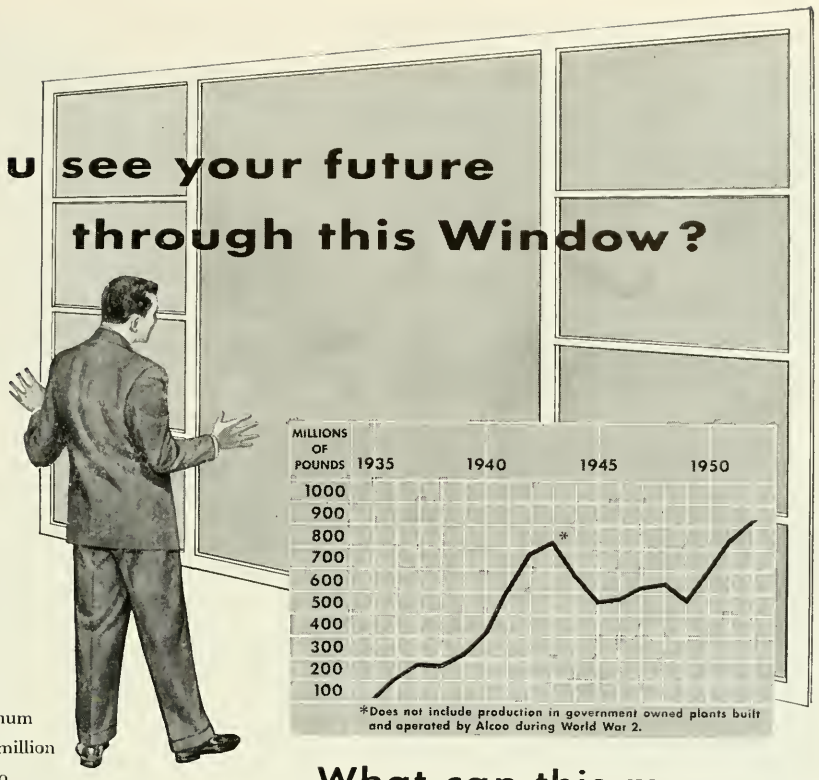
The application of science and technique and the creation of new things is involved in our profession. After a person dreams up a bridge, a road, a modern industrial machine, or a building, he has the satisfaction of knowing he has created something. There is nothing in the world as gratifying after a long time of work or effort as to know that one has created something out of his own mental capacities.

Even if a certain new gadget or industrial project wasn't merely one man's work, but the combined efforts of many, the gratification of having had a part in the designing, creating, or overcoming obstacles that came up during the course of the toiling, is often reward enough.

The world looks to engineers, and looks up to them in this Age of Science. They have designed such things as the Eiffel Tower, Boulder Dam, the Hudson Tunnel, Chevrolets and Fords, B-29's, safety razors, popsicles, roller coasters, washing machines, kiddie cars, and skyscrapers. They are the nucleus of our modern-day, never-slow-down civilization. They cause the world to continue to move on its many and varied wheels, pulleys, wings, rudders, tracks, and superhighways. The world rises by way of its buildings, spires, observatories, Bell X-1's, V-2 rockets, etc.—all of which are due to the untiring and unceasing efforts of the engineer. The engineering profession holds the key to the world's power in its vital control and knowledge of atomic bombs, multifire, auto-control weapons, ionosphere-flying crafts, electric power depots, Diesel-powered railroads, steamships, communications; in its invention and constant improvement of such things as electric mixers, light switches, television sets, automobile brakes, cigarette lighters, accurate timepieces, electronic bug killers, and innumerable other necessary gadgets in this, our modern-day world. These and similar things are either directly, or perhaps sometimes indirectly, the work of engineers, without whom our present structure of society would collapse. The many conveniences familiar to us and the many more which will be evolved in the ensuing years are being developed so that the human race will find it unnecessary to spend their time with such medial tasks as growing food and clothing, building fires, and so forth, and so that they may use their time contemplating and doing the deeper things of life. And the engineer is the one who develops and improves the mechanical side of our culture and thus benefits the people and helps to make this a happier world.

If you are the type of person who wishes to be an engineer in any of the preceding senses of such a creature; if you have the ambition and ability to work on the higher echelon of the intricate mechanistic and vital portion of our civilization, then there is little doubt that you will be happy in the profession of engineers.

Can you see your future through this Window?



This is an aluminum window, one of four million that will go into buildings in 1953. Twenty years ago, it was just an idea in the mind of an Alcoa development engineer. Ten years ago, only a few thousand were made annually. Now, production *is increasing* at the rate of over half a million a year. This is just one of a torrent of new uses for aluminum which means that Alcoa must continue to expand. Consider the opportunities for you if you choose to grow with us.

What can this mean as a career for you?

This is a production chart . . . shows the millions of pounds of aluminum produced by Alcoa each year between 1935 and 1952. Good men did good work to create this record. You can work with these same men, learn from them and qualify yourself for continually developing opportunities. And that production curve—is still rising, we're still expanding, and opportunities for young men joining us now are almost limitless.

Ever-expanding Alcoa needs engineers, metallurgists, and technically minded "laymen" for production, research and sales positions. If you graduate soon, if you want to be with a dynamic company that's "going places", get in touch with us. Benefits are many, stability is a matter of proud record, *opportunities are unlimited.*

For more facts, consult your Placement Director. ALUMINUM COMPANY OF AMERICA, Pittsburgh, Penna.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

STYLISH STEEL BRIDGE

edited by Paul E. LaViolette, E. E., '55

Freedom of form previously available only with concrete, has been achieved with steel materials in a bridge spanning the Rio Blanco River near Vera-Cruz, Mexico.

By applying welding techniques, Mexican engineer, Camilo Piccone, has projected a span with slender arch ribs, free of cumbersome bracing. The structure is based on a new design conception by Thomas C. Kavanagh, head of the department of Civil Engineering of New York University's College of Engineering.

The ultra-modern "basket handle" effect is heightened by the use of color. Painters have daubed the curved ribs orange and made the horizontal tie-girders cherry red. The bridge was opened last May and motorists who invariably stop to admire the striking architecture on their first trip across the span have created a minor traffic problem.

The 250-foot long, all-welded steel splayed-arch highway bridge accommodates three lane sof traffic. The arch ribs are inclined and joined at the center of the span. The resulting space framework produces visually interesting effects from different angles.

Unconventional design in the Rio Blanco bridge extends also to the flooring, where a diagonal gridwork of floor beams has proved far more economical than usual bridge floor system. Its strength and safety factors are as high as conventional constructions.

Dr. Kavanagh's original design conception won an award in the 1951 professional bridge design competition sponsored by The Lincoln Arc Welding Foundation of Cleveland, Ohio. Through the award, Mr. Piccone learned of Dr. Kavanagh's design.

The Rio Blanco span, part of the Mexican federal highway system, was constructed under the direction of the Papaloapan Commission. Contractors and fabricators were the firm of Estructuras, S. de R. L., of Monterrey.

"Allis-Chalmers Graduate Training Course Was Just What I Needed,"

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"Before starting on the Allis-Chalmers Graduate Training Course, I thought I would like selling, preferably technical selling but, as is often the case, I didn't know for sure. This course, together with some personal guidance, helped me make up my mind. That, too, is an important advantage of the GTC program.

"But whether you want to be a salesman or designer, production engineer, or research engineer, Allis-Chalmers, with its wide variety of equipment and jobs, is an ideal place to get off to a good start—without wasting time."

Facts You Should Know About the Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control, pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

7. For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

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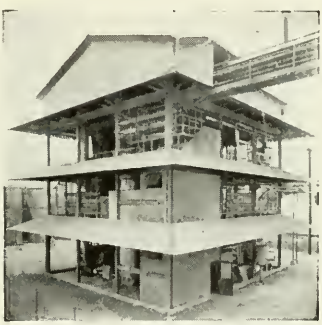
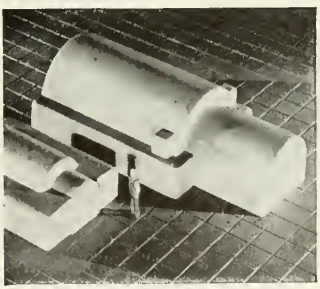


PROCESSING—Allis-Chalmers built solvent extraction plant processes one hundred tons of rice bran per day at oil processing plant in Texas.



POWER—Models show comparative size of generators having the same rating with and without super-charged hydrogen cooling. Allis-Chalmers is first to supply super-charged hydrogen cooling.

On the Banks of the Boneyard

by Martin Goldstein, Chem. E., '55

Dear Freshman,

You have been welcomed and guided, told where to go and where not to go so many times in this issue that it would be worthless to try that old story again, but I'm going to anyway—in a different form.

You've no doubt seen the "beautiful" little stream that flows approximately through the middle of the engineering campus. Well, this landmark will, in your four years on campus, become closer to you than your slide rule. It is a mark of distinction, one of the many things that sets the engineer off from the other people on this campus who call and actually consider themselves students. This stream is known as the Boneyard. This is where the column *"On The Banks Of The Boneyard"* gets its name. It is, we believe, a fitting title for a column of our engineering college magazine.

The engineer at the U. of I. has much to be proud of. He has the only college council on the campus which sponsors a major dance every year, *The St. Pat's Ball.* As you've probably guessed, this dance is held as near to St. Patrick's Day as is practical. Perhaps you're in the dark as to why the engineers have associated themselves with St. Patrick who converted Ireland during his lifetime. I must admit that this completely baffled me two years ago.

It seems that in 1903 a few of the engineering students at the University of Missouri "discovered by a revelation" that St. Pat was in reality an engineer. They celebrated St. Pat's Day that year by cutting all their classes and several other frowned upon activities. A few of the more active members of the plan found they would be absent from their classes quite a bit longer than they had expected. However, shortly thereafter the college recognized this as a regular engineering event, and the idea has rapidly spread. Each year one man from each of the engineering societies and one from the *Technograph* is designated as a Knight of St. Pat, and is duly honored at his Ball.

Quite recently "historical proof" has been found to bear out the fact that St. Pat was an engineer. An ancient document dating from the time of St. Pat was found in Ireland. On it were the words "Erin Go Bragh." With strictest "accuracy of translation" this means "St. Patrick was an engineer." His exactness and thoroughness make St. Pat a good example for any engineer. An example of this is the "exacting specifications" to which the churches in his time were built.

The council also sponsors the Engineering Open House which is held very near to St. Pat's Day. This event usually draws 15 to 20 thousand people each year during its two day sojourn. For this event the engineers begin planning in October or November since an event that require sthe work of 3000 people, faculty and students, and attracts 18,000 spectators requires a great deal of preparation.

Your mark of distinction is, of course, your slide rule. This little item hanging from your belt sets you apart from the rest of the students. It can come in very handy in emergencies—exams, etc., so treat it right.

As a last comment, I would like to request that if any of you have any journalistic talents whatsoever please drop around to the office and talk to one of us. We'd really like to have you, so take note of the ad on this page.

Keeping up with your neighbors is no difficulty in these days of picture windows.

* * *

It's just as hard to find a needle in a girl's hands today as in a haystack.

* * *

Puffing and blowing, the young man just managed to get on the platform of the last car as the train left the station.

A middle-aged man in the corner eyed him with scorn. "When I was your age, my lad," he said, "I could run half a mile, catch a train by the skin of my teeth, and yet be as fresh as a daisy."

"Yes," gasped the young fellow. "But I missed this one at the last station."

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HOW TO DESIGN FOR LOWER STRUCTURAL COSTS

WITH today's accent on cost, there is a promising future for the designer who can simplify structural designs to save steel and construction manhours. Such savings are being realized every day by the use of arc welding instead of riveting in the construction of all types of industrial plants, multi-story buildings and bridges. By eliminating rivets and taking advantage of rigid framing and continuous beam construction, welded designs help to offset the rising costs in labor and materials.

Shown below is a typical example of how full structural continuity achieved through arc welding effected savings of $22,000 in the construction of an 87,000 square foot process warehouse. Arc welding actually has saved 1.68 pounds of steel per square foot. At $0.15 per pound for fabricated steel, the saving amounts to $22,000 over the cost of steel alone had riveted design been used.

In spite of the rapid progress made in the construction field by the welding industry, new developments are taking place every day which are of prime importance to the structural engineering graduate. Latest information on welded structural designs is available in handbooks and bulletins simply by writing to The Lincoln Electric Company, Cleveland 17, Ohio.

Fig. 1. Process warehouse *for the Hale-Halsell Grocery Co., Tulsa, Oklahoma. Size 250' x 350' with 16' clear height. Contractor: Tulsa Rig and Reel and Manufacturing Co. Consulting Engineer: David R. Graham & Associates, Tulsa, Oklahoma.*

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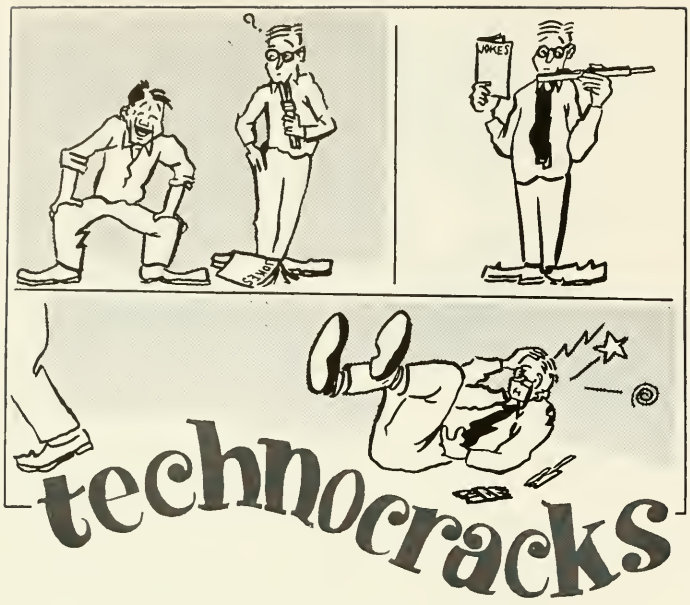


edited by Roger Funk, E. E., '56

"Cheer up, old man. Why don't you drown your sorrow?"

"She's stronger than I am, and besides, it'd be murder."

* * *

On one occasion an unusually large crowd gathered to listen to the long list of candidates. As evening approached the crowd began drifting away until one man remained in the audience. The speaker waxed eloquent and when he finished, rushed down, shook his hand and thanked him for his support. "You don't have to thank me, friend, I'm the next speaker on this program."

* * *

A merchant took out a fire insurance policy and the same day his store and contents burned to the ground. The insurance company suspected fraud, but couldn't prove anything. It had to content itself with writing the following letter:

> "Dear Sir: You took out an insurance policy at 10 a. m. and your fire did not break out until 3:30 p. m. Will you kindly explain the delay?"

* * *

A fellow was trying to start a conversation with the young lady who sat next to him at the table. "Do you like Kipling?" he asked.

The young lady giggled and then replied, "I don't know. How do you kipple?"

Composing a letter to the president of the firm, which he felt he so ably represented, the egotistical young salesman dictated to a stenographer:

"I feel that you should know, sir, that in order to obtain the above-mentioned contract, I found it necessary to employ every ounce of my personal charm and magnetism, my diplomacy and flawless tact. However, I am now pleased to report that my untiring efforts were crowned with success."

Gently the steno asked, "Crowtation marks on that last paragraph?"

* * *

Pat went to pay his respects to his friend Mike, who had passed away suddenly. Standing at the head of the casket, with Mike's widow alongside, Pat remarked, "Doesn't he look wonderful?" "Why not?" said the widow with a shrug, "he was in Miami all winter!"

* * *

A woman phoned her bank to arrange for the disposal of a thousand dollar bond.

"Is the bond for redemption or conversion?" a clerk inquired.

There was a long pause, then the woman asked: "Am I talking to the First National Bank or the First Baptist Church?"

* * *

The thing that keeps a lot of men broke isn't the wolf at the door, but the silver fox in the window.

"How far were you from the scene of the crime when the robbery occurred?" the lawyer asked the witness.

"Twenty-three feet and seven inches," the witness replied.

"How do you know so exactly?" the surprised lawyer inquired.

"Why, I thought some darn fool would ask me that question, so I measured it."

* * *

The 5th grade was having a geography lesson, and the teacher asked Bobby a question about the English Channel. "I wouldn't know about that one," the little boy shook his head doubtfully. "We only get one channel on our TV set."

* * *

At a dinner in Washington a noted man of letters was seated next to the young daughter of a naval officer. Her vocabulary was rather limited, but the turnover was amazing. "I'm awfully stuck on this guy Shakespeare," she confided. "I think he's tops. He's a wonder boy don't you think?"

"Yes," agreed the scholar solemnly. "I do think he's interesting; in fact, I think Shakespeare is just simply too cute for anything."

* * *

If a lot of other people who haven't been worrying about things in general don't start pretty soon, we're going to quit, too.

* * *

"Now, boys," said the Sunday School teacher, "if we are good while on earth, when we die we will go to a place of everlasting bliss. But suppose we are bad what will become of us?"

"We'll go to the place of everlasting blisters," answered a small boy at the bottom of the class.

* * *

"Henry, dear," complained the little woman, "I've noticed lately that your kisses are getting colder."

"Nonsense, darling," rejoined the wily Henry. "You've simply been getting your cosmetics on a bit thicker."

* * *

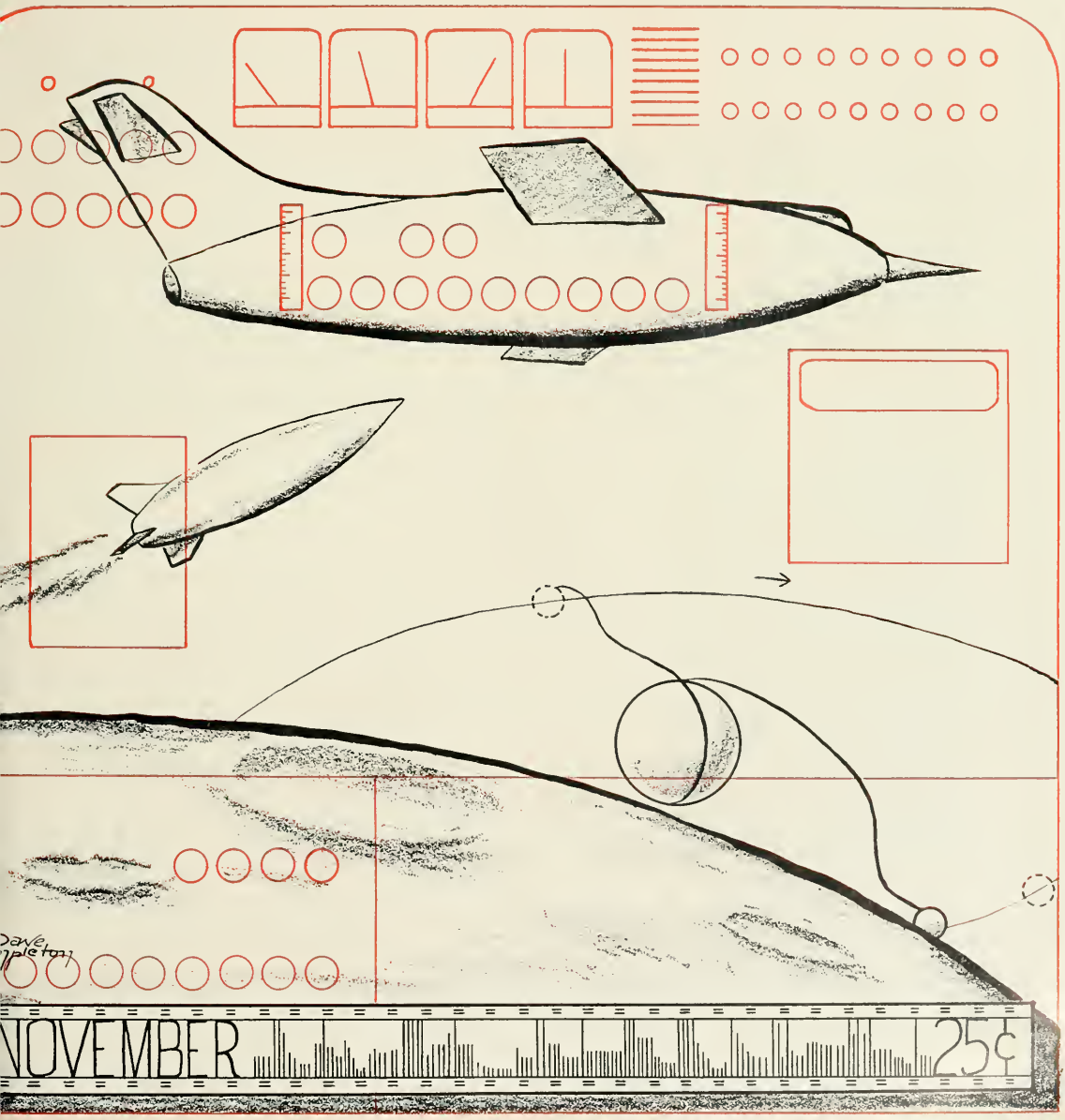
A young hopeful wrote his first novel and submitted it to a great publishing house. He called it "Why Am I Living?" In a few days he received the following message from the publisher: "Under separate cover I am returning your novel "Why Am I Living?" The answer to that is simple. Because you didn't bring it in personally."

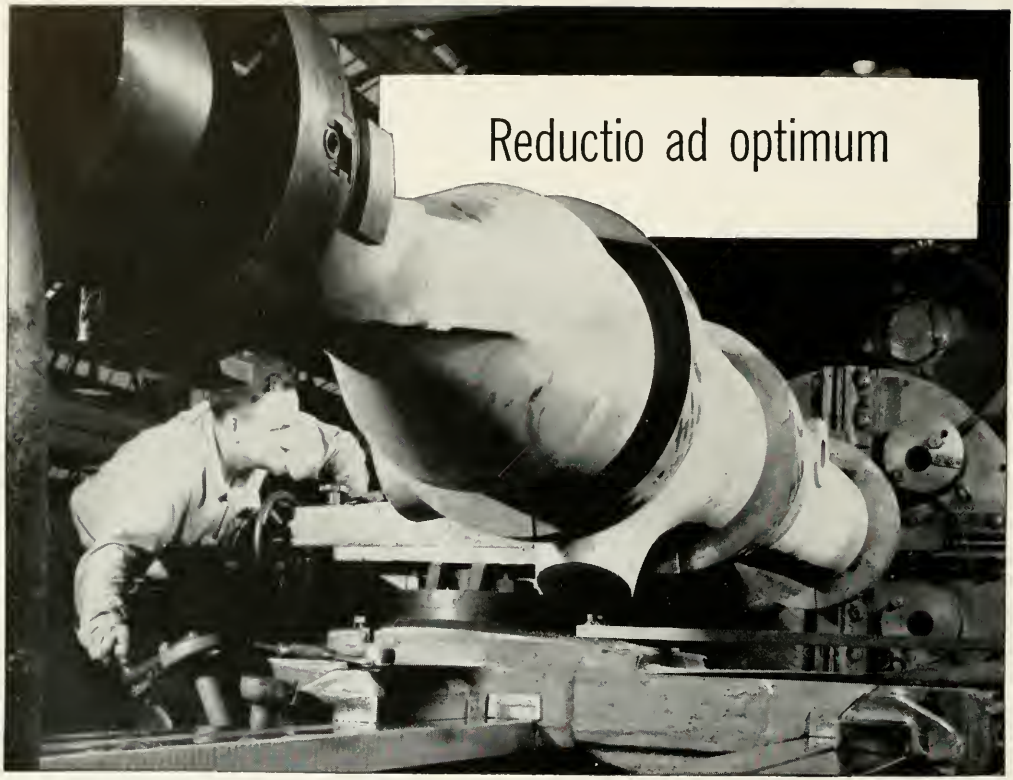
* * *

The Negro woman stated she had four children, and the Florida census taker asked for their ages.

Violet: "Ah don't zackly remembah, but ah's got one lap chile, one floor creeper, one porch chile, and one yard youngun."

ILLINOIS TECHNOGRAPH





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Published eight times during the year (October, November, December, January, February, March, April and May) by the Illini Publishing Company. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois, under the Act of March 3, 1879. Office 213 Engineering Hall, Urbana, Illinois. Subscriptions $1.50 per year. Single copy 25 cents. Reprint rights reserved by *The Illinois Technograph.* Publisher's Representative—Littell Murray-Barnhill, 605 North Michigan Avenue, Chicago 11, Ill. 101 Park Avenue, New York 17, New York.

THE ILLINOIS TECHNOGRAPH

volume 69 number 2

contents:

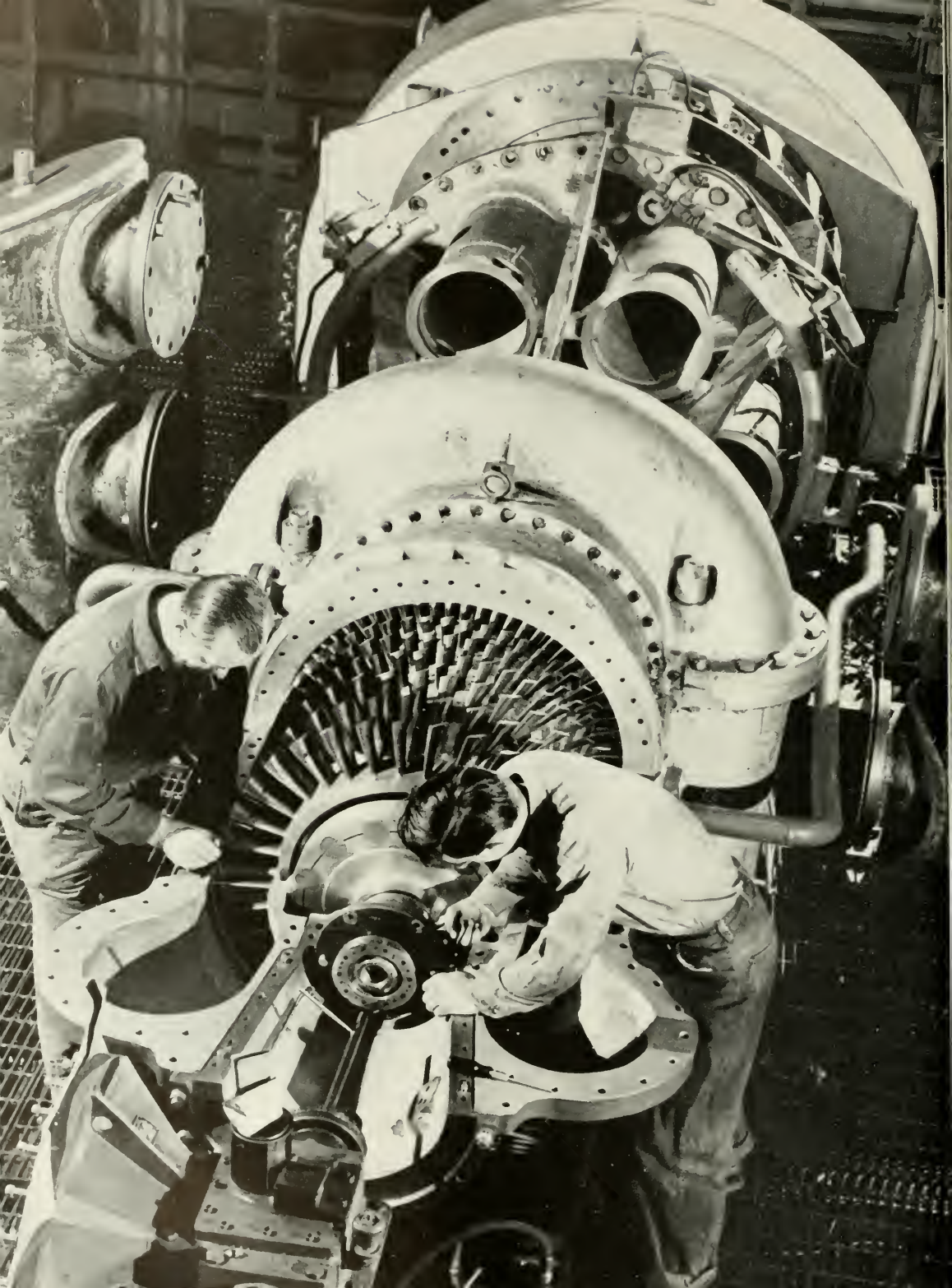
rocket development ---- 7
racing champions ---- 12
rocket reviews ---- 14
the moon is blue ---- 16
pier pilings ---- 20
science fiction ---- 24
radar and your weather report ---- 26
the fighting illini '53 ---- 32
introducing ---- 36
ecma convention ---- 40
the multistage rocket ---- 44
meet patsy scott ---- 46
engineering societies ---- 50
little blue rotameter ---- 54
skimming industrial headlines ---- 58
my slide rule ---- 62

our cover

This month's cover depicts several aspects of present rocket development. Shown in thhe sky are a Douglas D-558 and a V-2 rocket. In the lower right hand corner is a proposed travel to the moon and return. The overlay is an automatic control panel for a rocket with a tape recorder automatically recording flight information. The cover is by Dave Templeton.

our frontispiece

The gas turbine, a versatile new source of power for industry, is now being successfully used to pump natural gas through pipelines. A 5,000 hp. two-shaft, regenerative cycle, gas turbine is shown being assembled for the El Paso Natural Gas Company. (Cut courtesy General Electric)



Rocket Development

by Tom Hoffman, Arch.E. '55

Since man became aware of his surroundings he has looked at the night sky and wondered about the stars. Before astronomy developed into an exact science, man resorted to superstition and fable to explain this phenomenon. The astronomer-priest of ancient Babylon observing the night sky knew that the red star was Mars but not that it was the next planet outside the orbit of the earth. To the priest, Mars was the abode of a certain god. The ancient Chinese astronomer recognized different cycles and was able to predict eclipses. They developed several astronomical instruments to help them in their observations. But to them the world was flat and the sky was a dome set with fixed stars.

As the civilizations grew, the Earth was theorized as a sphere. Heraclides, a student of Plato, argued that the Earth was the center of the Universe. Aristotle agreed with this belief and the Christian teachers accepted it a thousand years later. Because of this, astronomy had its biggest set-back. Anyone who disagreed with the Earth-centered universe was accused of teaching against the Church.

Nicholas Copernicus and Johannes Kepler provided a new understanding of the solar system. Galileo Galilei, with his homemade telescope observed worlds in the solar system. Later, Sir Isaac Newton broke down all opposition with his laws of motion. After the nature of the solar system was explained, a whole literature of space travel began to develop. The criticism was both serious and sarcastic, but the important fact was that men dreamed of space travel before the development of the first airplane.

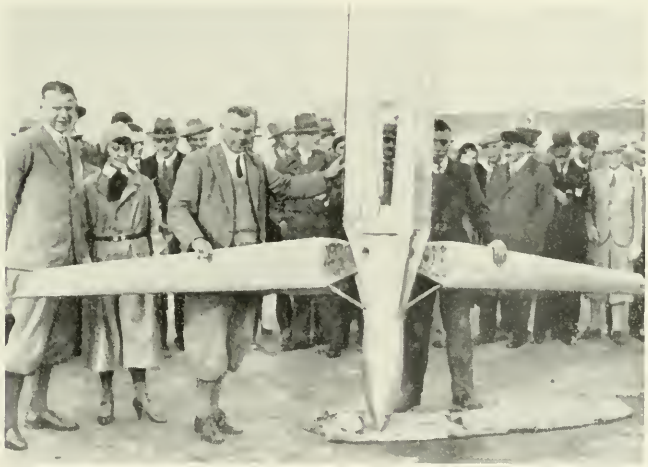
It is to Newton's third law, "To every action there is an equal and opposite reaction," that we owe one of the most far-reaching advancements in science—the development of the jet-reaction engine. For the first mention of the use of the rocket we must go back to the ancient Chinese. It has been said that the rocket was invented in China in 3000 B.C., but the oldest date found was from a Chinese Chronicle from the year 1220 A.D. The Greeks made use of flaming projectiles known as Greek Fire, but this was a pure incendiary without explosive materials. Fireworks were introduced in Europe in the thirteenth century but by the fifteenth century rockets were used in warfare, taking the place of the crude cannon.

Experiments were made with rockets, but only Colonel William Congreve, M.A., at Woolwich Laboratory in England, was successful. When Sir Sidney Smith's Expedition set out against Boulogne, Congreve accompanied him with a number of boats fitted for rockets. Boulogne was bombarded by rockets in 1806 and was forced to surrender on November 27th. The Congreve rockets were again used by the British against Copenhagen in 1806. The greater part of the city was burned to the ground, set aflame by about twenty-five thousand rockets. The rockets weighed 32 pounds each, measured three feet, six inches long and four inches in diameter. They were made of metal cases with a stick fastened to the side to serve as a stabilizing device.

The rockets became obsolete at the end of the nineteenth century. They were undependable, inaccurate, and more often dangerous to friends than enemies. In its place stepped the rifled bore, breech-loading rifle, and the Stokes motor.

The period of modern rocket research begins with the work of Dr. Robert H. Goddard, of Clark University. The idea of using rockets to reach great altitudes and even interplanetary flights goes back as far as 1660, but Dr. Goddard was the first to experiment and write scientific work on the subject. Dr. Goddard had the idea of using hydrogen and oxygen as fuels for a rocket and the construction of a step-rocket design in 1909. He put his theory in satisfactory form in 1912 and began experiments about 1914. His first tests were made by solid-fuel rockets, but by 1916 he had reached the limit of his own resources.

In an attempt to secure funds for his research, he submitted a paper to Dr. Charles D. Walcott, then secretary of



Reinhold Tiling demonstroting one of his winged rockets at Hanover, Germany.

the Smithsonian Institute. The funds were obtained, totaling $11,000, and his paper was published in 1918, entitled "A Method of Reaching Extreme Altitudes," as part of the Smithsonian Miscellaneous Collections, Volume Seven, Number Two.

The main reason behind Goddard's thinking was the purpose of investigating atmospheric conditions at extreme altitudes. The importance of such an investigation was outlined by Goddard:

"The greatest altitude at which soundings of the atmosphere have been made by balloons, namely, about 20 miles, is but a small fraction of the height to which the atmosphere is supposed to extend. In fact, the most interesting, and in some ways the most important part of the atmosphere, lies in this unexplored region a means of exploring which has, up to the present, not seriously been suggested.

"A few of the more important matters to be investigated in this region are the following: the density, chemical constitution, and temperature of the atmosphere, as well as the height to which it extends. Other problems are the nature of the aurora, and (with apparatus held by gyroscopes in a fixed direction in space) the nature of the Alpha, Beta, and Gamma radio-active rays from matter in the sun as well as the ultra-violet spectrum of this body."

The search for some means of raising recording instruments to the upper atmosphere led Dr. Goddard to develop a theory of rocket action. His problem was to determine the minimum amount of fuel needed to raise a one pound mass to any desired altitude. He found that a small mass of propellant would be necessary if the gases were ejected from the rocket at high velocity and provided that most of the rocket consisted of the propellant material. Later Dr. Goddard estimated that it would require 1,000 pounds of gunpowder to send a weight of one pound completely away from Earth. But a liquified mixture of hydrogen and oxygen would propel the same weight with only 43.5 pounds of fuel.

An attempt to reduce weight led to the development of the multiple-stage rocket. This is a series of projectiles. When one rocket burns out, it drops off, relieving the main projectile of its dead weight and allowing the rocket to increase its speed.

Dr. Goddard proposed sending a rocket to the moon carrying a load of flash powder that would explode to mark its arrival. He commented:

"This plan of sending a mass of flash powder to the surface of the moon, although a matter of much interest, is not of obvious scientific importance."

The newspapers seized upon the idea of sending a rocket to the moon and exploding into a huge flash. Even more important to the newspapers was that this idea came from a man with a Ph.D., teaching physics, rather than some halfmad inventor, and that the Smithsonian Institute was backing him.

Dr. Robert H. Goddard with one of the rockets he launched in 1932 at Mescalero Ranch near Roswell, N.M.

The article caused some comment from the critics but it remained unknown in Europe for a number of years. The importance of the book was not immediately noticed as Europe, in 1920, had worries of war and political uprisings. And in happy and prosperous America the book was easily overlooked.

Critics in some of the research circles accepted the fact that a rocket could operate in the atmosphere but argued that the rocket, while in space, had nohing to push against. Dr. Goddard, answered his critics by demonstrating that a revolver fired in a vacuum had the same recoil as when fired in the atmosphere.

Dr. Goddard began experiments with a rocket motor in a vacuum to test its operating efficiency. He constructed a 24 foot tube and placed the rocket with a pressure indicator in the tube. After pumping out the air the rocket was ignited. The test showed that the rocket did not depend on the air to push against and that it exerted 20 per cent more lifting power.

With grants from Clark University and the Smithsonian Institute, Dr. Goddard began to experiment with liquid fuels for rockets in 1920. After some trials, he decided that the best fuel would be a combination of liquid oxygen and gasoline. This data gave him a basis for designing a rocket. On November 1, 1923, a rocket motor was tested in a proving stand, without an attempt to fly, using liquid oxygen and gasoline supplied by mechanical fuel pumps. The test was promising, but there was a problem of supplying fuel

to the combustion chamber fast enough. In December, 1925, Dr. Goddard overcame this difficulty by using an inert gas, nitrogen, under pressure to force the fuel into the chamber.

The first liquid-fuel rocket flight in the world was made on March 16, 1926, in Auburn, Massachusetts. The rocket was 10 feet long with the motor ahead of the fuel tank connected by spidery arms which carried the fuel lines. It was ignited by a blowtorch, and the gas pressure was maintained by a small alcohol burner within the rocket. The rocket rose to 184 feet in 2.5 seconds, making a speed along a trajectory about 60 miles per hour. The historic flight was witnessed by only Dr. Goddard and three assistants. Dr. Goddard abandoned the idea of putting the motor ahead of the fuel tanks in favor of rockets with the motor in the rear.

On July 17, 1929, Dr. Goddard developed a rocket to carry a barometer and a small camera which were successfully recovered. It was a large rocket and made a great deal of noise. The flight was witnessed by a neighbor some distance away who mistook the rocket for a flaming airplane and telephoned the police. A few were certain a meteor had fallen. The majority of the newspapers reported that Dr. Goddard had attempted to send a rocket to the moon but had failed. Others claimed that the rocket had contained tons of explosives and his intentions were to fly to Mars.

The publicity resulted in interrupting the work for several months. The state fire marshal refused to give permission to make tests on state propery. With the help of Dr. Charles G. Abbot, secretary of the Smithsonian Institution, Dr. Goddard obtained permission to use part of the artillery range at Camp Devens, Massachusetts, from the War Department. Progress was made with difficulty, because the experiments could only be made when snow or rain covered the ground.

In 1929, Col. Charles A. Lindbergh became interested and brought rocketry to the attention of Mr. Daniel Guggenheim. The result was a grant that made possible rocket work for a two year period, to be followed by an additional two years if the members of an advisory committee was satisfied with the results. The advisory committee was as follows: Dr. John C. Merrian, chairman; Dr. C. G. Abbot; Dr. Walter S. Adams; Dr. Wallace W. Atwood; Col. Henry Breckinridge; Dr. John A. Fleming; Col. Charles A. Lindbergh; Dr. C. F. Marvin; and Dr. Robert A. Millikan.

East central New Mexico was selected because of clear air, few storms, moderate winds, and level terrain. The research group moved in July, 1930 to Roswell where power and transportation was available.

In September, 1930, a shop, the 60-foot tower previously used at Camp Devens, and a 20-foot tower for making static tests, were erected. During static tests, the rocket was prevented from rising by weights so that the lift and performance could be studied. A concrete gas deflector was constructed to direct the gases away from the rocket.

The combustion chambers constructed at Clark University underwent a series of thorough tests in which the operating conditions were varied. Modifications such as the pressures of the fuels, proportions of the liquids, and size and shape of the chambers were added. The motor decided upon was 5 3/4 inches in diameter and weighed 5 pounds. It developed a maximum lift of 289 pounds and operated over 20 seconds. The variation in lift was steady, being within 5 per cent.

V-2 rocket carrying a WAC-Corporal which reached an altitude of 250 miles on February 24, 1949.

The first flight test made was on December 30, 1920, with a rocket 11 feet long and weighing 33.5 pounds. The rocket rose rapidly from the tower, reaching a speed of 80 miles per hour and a height of 2000 feet in 7 seconds. The parachute did not release, and the rocket landed about 1000 feet from the tower.

The first flight with gyroscopically controlled vanes was obtained on April 19, 1932. The method of stabilization consisted in forcing vanes into the blast of the rocket, but they were too small to produce rapid correction. The rocket rose slowly from the tower and landed 5 seconds later, striking the ground on its side.

In May, 1932, the results that had been obtained were placed before the advisory committee which voted to recommend the two additional years of research; but because of the death of Mr. D. Guggenheim and the economic depression, it was impossible to continue work in New Mexico.

Dr. Goddard returned to full-time teaching at Clark University in the fall of 1932 and worked on general problems related to rockets. Most of this work was made possible by a grant made by the Smithsonian Institution in September, 1932, and a grant from the Daniel and Florence Guggenheim Foundation.

The work was resumed in the summer of 1934 by a grant from the Daniel and Florence Guggenheim Foundation. This came at an opportune time, because the work in the laboratory had reached a point where it could not go on effectively without flight performance.

Work began in September, 1934, with the shop put in order and tower equipment replaced. The main project was to develop some means of keeping the rocket on its course by automatic stabilization. A pendulum stabilizer was used in the first test because it was more easily constructed and repaired than a gyroscope. The pendulum stabilizer could correct the flight for the first few hundred feet where the acceleration is small, but not satisfactorily when the acceleration is large. The pendulum extends in a direction which is the resultant of acceleration and pull of gravity, therefore, remaining vertical when the rocket is inclined. The rocket rose to about 1000 feet, then leveling nearly horizontal until the end of the flight. It then landed 9000 feet from the tower traveling at 700 miles per hour.

On March 25, 1935, a gyroscope controlled flight was made. The gyroscope was set to operate when the axis of the rocket deviated 10 degrees or more from the vertical. The rocket rose unsteadily, but then went into a smooth flat trajectory. This showed that the

gyroscope was able to control and keep the rocket in its course. The rocket rose to a height of 4800 feet, reaching a speed of 550 miles per hour.

No attempt was made in these flights to reduce the weight of the rocket, which varied from 58 to 85 pounds. A reduction of weight would have been useless until stabilization could be maintained. The important developments that came from Dr. Goddard's work between 1930-1935 were an efficient rocket motor, stabilization that would operate

Viking rocket ready for launching at White Sands proving grounds.

automatically and study of rocket performance in flight.

Professor Herman Oberth, who could be ranked with Dr. Goddard, published the first edition of his book, *Die Rakete zu den Planeteuraumen* (The Rocket into Planetary Space), in 1923. Dr. Oberth led those interested in rockets in Germany and suggested several rocket ideas but did not get a chance to work on them until 1929. His book was divided into three parts—the first dealing with rocket principles and the second describing a rocket for upper-atmosphere research. The third, of interest to the layman, discussed problems of space flight and described the concept of a space station.

Dr. Oberth proposed to send a rocket above the atmosphere that would circle the Earth continually by neutralizing Earth's gravity with centrifugal force.

In the fall of 1928, Fritz Lang of U.F.A. Film Company, called Dr. Oberth to serve as technical advisor for the film, "Frau im Mond" (The Girl in the Moon). An agreement was made that the company would finance a rocket to be sent into the air on the premiere of the film. The agreement did not hold, and Lang and Oebtrth spent their money for the experiments.

Oberth did not have enough time for all the experiments, and when the film was released, his rocket did not materialize. The premiere of it was on October 15, 1929, in the UFA Palace in Berlin. Dr. Oberth did develop a satisfactory motor which he called the Kegeldusе. It was a cone shaped motor, made of steel with a copper lining.

Some of the rocket attempts were doomed to prove failures such as efforts toward propelling vehicles. Max Valier, a charter member of the Verein fur Baumschiffahrt (The German Rocket Society), interested Fritz von Opel, the German car manufacturer, in building a rocket automobile. Opel was impressed by the first trials and arranged a public demonstration. A car was developed that carried twelve powder rockets and obtained a speed of 70 miles per hour in 8 seconds.

Opel then designed a streamlined car with stubby wings that would press the car against the road. Opel demonstrated the car himself on the Avus Speedway near Berlin on May 23, 1928, reaching a speed of 125 miles per hour. As described by one observer: "The Opel rocket auto locks like a multiple-barreled piece of light artillery in speedy retreat."

The main problem to overcome was to prevent the metal of the motor from heating up. The burning temperature of gunpowder is above the melting point of steel, but in the short time of operation no immediate harm resulted. The one solution to prevent the heating of the motor was by cooling it.

Opel went on to develop rocket railroad cars, but most of them jumped the tracks and were destroyed.

Later, in 1920, Max Valier was killed while working on a car which was propelled by a liquid fuel motor for liquid oxygen and gasoline. He was the first rocket experimenter to give his life for his work. Valier was "idling" his motor and observing at close range when the motor exploded .

Fritz von Opel switched to rocket airplanes and made the first successful flight on September 30, 1929, at Frankfort, Germany. The glider took off from a rocket propelled car on a track, reaching a speed of 95 miles per hour in 75 seconds, and flew for 1¼ miles.

The first rocket flight was made by Friendrich Stamer in the Rhon Mountains of Germany on June 11, 1928. His glider, Ente, was launched by a catapult, and then the rockets were fired. The flight covered 1500 yards in 80 seconds. His experiment ended in an explosion of a rocket and the burning of his glider.

The first rocket flight in the United States was made by W. G. Swan in 1931 at Atlantic City, New Jersey. Swan took off and reached an altitude of 200 feet. In the same year, in Italy, Ettore Cattaneo made a successful rocket flight covering a mile in 30 seconds.

From these tests, the results showed that the rocket applied to the airplane was useful only when speeds for a short period were necessary. A rocket applied to the practical motor car was limited to speeds of 100 miles per hour, due to the air resistance. The rocket was forced to be viewed as an instrument for other than terrestrial transportation.

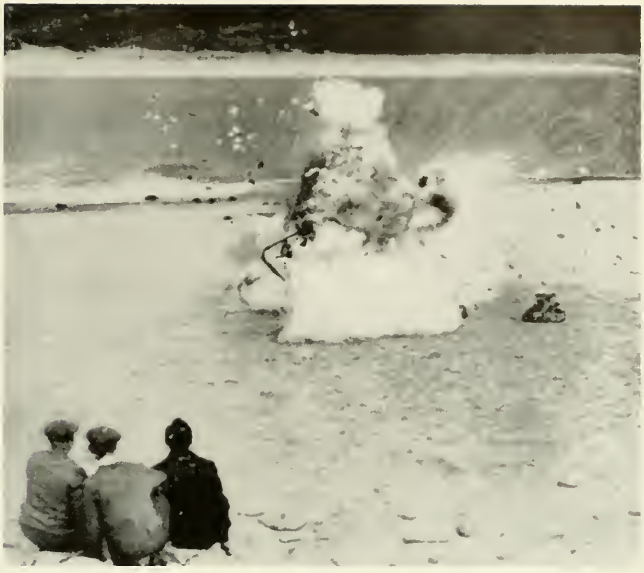
In New Mexico, Dr. Goddard continued his experiments with rockets. Tests were made to develop a more powerful motor that operated on liquid nitrogen. Part of his experiments consisted of the development of light weight fuel pumps that inject fuel rapidly into the rocket motor. The approaching World War II terminated the work and Dr. Goddard accepted applications to work on war rockets for the Army and Navy. The physicist had planned to return to New Mexico immediately after the war to work on high altitude rockets. His death on August 10, 1945, brought to an end the most important career in science. But Goddard lived long enough to see his dream materialize into one of the most significant fields of engineering.

In 1940, the United States began to experiment with the rocket as a weapon of war. Most of the rockets developed were fin-stabilized such as the bazooka rockets. Bombardment rockets were developed for launching from tubes under the wings of fighter planes and from tanks on the ground. Anti-submarine rockets were developed by the British and improved by the United States and known as the "hedgehog." Twenty-four of these rockets were fired from a ship to the approximate location of a submarine. The rockets sank head down and exploded only when direct contact with the submarine was made.

The extensive research by the Ger-

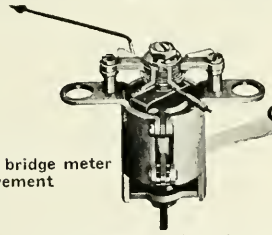
mans during World War II led to the successful launching of the A-4 (known as the V-2) on October 2, 1942. The A-4 was a fin-stabilized rocket, 46 feet, 11 inches in length, weighing 28,229 pounds. The first V-2 to bombard London was fired on September 8, 1944. On June 12, 1944, Germans launched the first flying bomb against the British called the V-1. The average range of the V-1 was 150 miles and it was capable of accelerating to a speed of about 360 miles per hour. 7488 V-1's were reported launched, while about 32% reached their target.

Dr. Wernher von Braun, who co-designed the V-2 and is now working for the U. S. Army, believes that it is possible now to construct a satellite space station from which a trip to the moon and the other planets could be made. From the station, all portions of the Earth could be observed except that region above the Arctic circle and below the Antarctic circle. Such a station would be valuable for observations of the Earth and the outer reaches of the Universe. The most important aspect is that it could serve as a refueling base for a rocket ship enroute to the neighboring planets.



Explosion of an early experimental mail rocket in England

Many people who do not know the importance of the rocket will ask, "Of what use is it?" Michael Faraday, when working on electricity said to a woman who asked him what use was electricity, replied with the question, "Of what use is a new born baby?" With the rocket today, the world will see the first manned space ship on the moon within the next few years. After this flight, the conquest of the solar system will begin. To think and plan for interplanetary travel is no more out of place than what has been done in aviation within the last 50 years.



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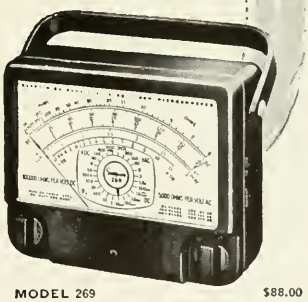

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Racing Champions

by C. E. McMullen, Comm. '53

The average American car-owner has a definite and prejudiced image of a hot-rod; a souped-up, old jalopy driven by some wildeyed youngster, usually seen bulling through traffic, with fenders flapping and exhaust stacks rumbling. True as this statement may be, there are tracks where supercharged old jalopies such as these can race under supervised authority.

Two of the main hot-rod racing areas of the United States are in Burbank, California, and the Bonneville Salt Flats in Utah. These areas are ideal for racing because of their many miles of flat surface. The hot-rod driver, because of the fast rate of speed at which he travels, needs a flat surface to insure the maximum amount of speed from his auto and above all to insure his safety.

The Annual National Hot-Rod Time Trials, which are usually held around August 31 through September 6, draws some 250 drivers from as many as 18 states, all competing for the name of "Champion Hot-Rod Driver." These serious minded men have constructed cars with not only power, lightness, and efficient contours, but also with a highly selective gear box, superb brakes, which at the slightest touch will produce a safe means of stopping, and above all a suspension which is at once comfortable and road-gripping, to facilitate fast cornering. The racer wants speed in a straight-away, and wants to be able to shift down and brake hard for acute turns, often at speeds under 30 miles per hour, and then shift up with powerful acceleration until he is at maximum speed.

Speed is the main object in building a hot-rod. When you think of speed, the next word that comes to your mind is safety. Safety and speed, in that order, are the principal factors in the brain of a hot-rod mechanic; however, speed must be the dominant one of the two in order to win the name of "Champion Hot-Rodder."

Each hot-rod entered in the Annual National Hot-Rod Time Trials is hand built from standard stock parts and revamped for racing. Most of the cars driven by hot-rodders are revamped to look like streamliners, so-called because of their envelope body design. The main reason thought of in building these cars is to attain a high rate of speed. These cars are capable of exceeding speeds of well over 200 m.p.h.

Everything on the car must be perfect before entering the nationals. In the case of the superspeed streamliners, the first thing we encounter is the body. The materials used for the body and the methods of construction are relatively unimportant, provided of course that the strength requirements are met.

In matters of body contour, the hot-rodder is very practical. Should a problem arise that he thinks is too hard, he seeks the advice of an expert. The body design of a 300 m.p.h. streamliner is a very difficult and scientific proposition that must be handled by competent aerodynamicists. Most streamliners have had exhaustive wind tunnel tests made of prototype design models, a service provided by some of the better research laboratories.

The building of a streamliner is a long, tedious job. In one type, the chassis used is part of a Davis three-wheeler tubular frame. All bulkheads and body shapes would have to hand-made from aluminum extrusions and sheets. A front suspension seat could be obtained from a 1928 or 1930 Ford and narrowed about 10 inches, with 1940 Ford spindles and brake assemblies. The rear end of the streamliner could be made from a Model A, narrowed about 10 inches. One streamliner that set international records at Bonneville Nationals in the Class B Division had an engine with a 3¼-inch bore, 3¾-inch stroke, 248 cu. in Merc, equipped with C & T heads and fuel injectors, Iskenderian cam and Scintilla-Vertrex magneto. Special interest centered about the heads and injection system. A hemispherical combustion chamber was employed, the valves being 90 degrees apart. Intake valve size was 1 5/8 inches and the exhaust 1 and 7/16 inches. Although the heads were aluminum castings, standard steel intake and exhaust valve seat inserts were used and were placed into position with a .007-inch interference fit.

Fuel for the injectors is supplied by a re-worked Pesco aircraft pump, driven by a pulley and V-belt from the right-hand water pump. Fuel is pumped under pressure, 35 psi maximum, to a metering valve, and from there is injected into the airstream of each of the individual ports. The choice of a slide-valve type of throttle is an ideal one for straight-away runs, for when the throttle is wide open, there are none of the usual restrictions in the port; restrictions such as throttle butterflies and throttle shafts, which generally result from a considerable percentage of the port area, in this case are completely absent, thus allowing more air to enter the engine. Compression ratio of 12.5 to 1 is obtained by using pistons with a high crown, machined for valve clearance. Horsepower output of the engine is 280-5050 rpm, using straight alcohol, and 320-5050 rpm, using a 50-50 mixture of alcohol and nitromethane. This mixture was used on all the AAA timed runs. These figures represent 1.14 bhp per cubic nitrated fuel; in either case, remarkable values from a reworked, production-line engine.

It is extremely interesting to study the different frame structures of the hot rods. In most cases, the streamliners have truss-type frames fabricated from sections of steel tubing. This type of frame is a good compromise between light weight and extreme rigidity. These two factors combine to make this frame type particularly well suited for high-speed travel plus the fact that either a metal or plastic body may be fastened directly to the frame, which eliminates the need for many outrigger body supports.

In the matter of suspension systems, the tried and proven solid-type front and rear axle assemblies insure predominance. Most of the cars use tubular axles for their lightness and rigidity, and at the back, reworked Ford rear end components are the most popular and least expensive. However, some cars are constructed with open-tube rear ends, similar to those used in sprint and championship track cars. There were deviations from this, in that at least one car was being built with swing axles and quick-change differentials both front and back, thus creating a four-wheel drive machine to be powered by two inde-

pendently operated Chrysler V-8 engines. Another car boasted a true De Dion rear suspension in which all major replacement components could be purchased over the counter. The suspension medium for most of these cars was the venerable transverse leaf spring, although a few builders favored either coil springs or torsion bars.

Fuel is extremely important to the hot-rod driver, for the right kind of fuel may mean success. The octane number refers to the fuel's degree of knock resistance. The higher the number, the less knock. One builds up the octane ration of gasolines by adding tetraethyl lead or special petroleum constituents obtained from refining and cracking process. Most of the knock gremlins are born when fuel is burned inefficiently in the engine. If the fuel mixture burns evenly, not all at once, the piston gets a firm, steady push. If it burns in a flash or before the piston is ready for the push, there's knock in the engine.

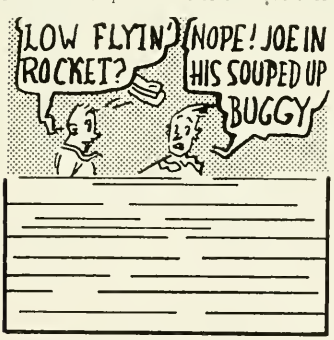
Fuel is still in the experimental stage as far as use in hot rods is concerned. Many formulas have been tried, and as many theories have been expounded as to why any one is the best. Experimentation with fuels is a natural step forward in the hot rod sport. The utilization of advantages offered by additives should not be viewed with any more alarm than was the general change from gasoline to methanol. At the present time, and for a very good reason, additives are being used only with methanol. The reason is that additives are now being used is that they will not mix with gasoline.

Converting an engine to improve its performance involves altering the mechanical details which control its volumetric efficiency. Improvements are also made to better utilize the power developed so that less of it is absorbed in the engine itself and more is exerted on the driving wheels of the car. Normally aspirated engines are dependent on atmospheric pressure to force the fuel and air mixture into the cylinders and to always have a volumetric efficiency considerably less than 10 per cent. This is because of the short time allowed for the cylinders to receive a charge and also because of the many obstructions and changes of direction by the mixture in the induction system.

The temperature of the mixture when it enters the cylinder has much to do with volumetric efficiency, because, as we all know, air expands and becomes lighter when heated and contracts and becomes heavier when cooled. Consequently, a volume of air at a given temperaturre weighs less and therefore contains less oxygen than the same volume of air at a lower temperature of the mixture. The induction system increases both the weight of the charge inducted into the cylinders and the volumetric efficiency of the engine.

The conclusions from the foregoing are these: there are two normal ways to increase volumetric efficiency of an engine—first, perfect the mechanical conditions concerned; and second, increase the weight of the charge in the cylinders by reducing its relative temperature. Also mentioned was a third way of increasing volumetric efficiency by providing oxygen in the cylinder in addition to that provided by normal means.

There are many different cars entered in the Nationals, and therefore the cars are classified in six different groups. They are classified according to their engines' cubic-displacement, the smallest being 91 cubic inches of cylinder space. This tiny engine when put in a Lakester racer body, which is just a bullet-shaped airplane-wing fuel tank, can get up to 188.98 m.p.h. Here are a few records of what the back yard mechanics have turned out. Le Roy Neumayer, 23, from Compton, California, drove a 300 plus h.p., 305 to 488 cubic inch streamliner for a record of 233.31 m.p.h. for five miles, and 230.55 m.p.h. over a ten-kilometer distance. Mal Hopper, 25, who works for the Los Angeles Telephone Company as a lineman, drove a streamliner with a cubic-inch displacement of 399 overr ce-



ment-hard flats, exceeding 230 m.p.h. at distances from one kilometer to ten kilometers, setting six new international records.

A new international record was established last year, September 13, 1952, in the class "C" division by a streamliner, "The City of Burbank," at an average of 229.77 m.p.h. If science in the field of cars keeps advancing as it has been in the last few years, then all the 38 records, International and National, will be broken annually. In 1952, 28 out of 35 records were broken at the Nationals.

Just as significant to the hot rod sport, perhaps, is the quantity of rewards to be received at the Nationals. In an atmosphere of cooperation and sincere fellowship, ideas, experiments, and experiences are exchanged, and problems discussed. Here the East meets the West with enthusiastic rivalry. In this typically American process, the character of the hot rod sport becomes more progressive in spirit and more out-standing in accomplishment.

Some information for this article was taken from the magazine "Hot Rod," 1954 Annual.

At 20 you blush when a man praises you; at 30 you think him a clever fellow; at 40 you wonder what he wants.

* * *

They were entertaining friends in their new prefabricated home. Suddenly one of the guests sat up and listened.

"Surely you're not troubled by mice already?" she said.

"That's not mice," replied the householder. "That's the people next door eating celery."

* * *

Diner: "I can't eat this soup!"
Waiter: "Sorry, sir. I'll call the manager."
Diner: "I can't eat this soup."
Manager: "I'll call the chef."
Diner: "I can't eat this soup."
Chef: "What's wrong with it?"
Diner: "I don't have any spoon."

* * *

A wedding ring may not be as tight as a tourniquet, but it certainly stops the wearer's circulation.

* * *

A Sunday School teacher had been telling a class of little boys about crowns of glory and heavenly reward for good people.

"Now tell me," she said at the close of the lesson, "who will get the biggest crown?"

There was silence for awhile: then Johnny replied: "Him wot's got the biggest head."

* * *

"Grandpa, why don't you get a hearing aid?"

"Don't need it, son. Hear more now than I understand."

* * *

Congressmen wouldn't have so dern many political fences to mend when they get back home if they hadn't done so much straddling.

* * *

The young man was rather shy, and after she had thrown her arms around him and kissed him for bringing her a bouquet of flowers, he jumped up and grabbed his hat.

"Oh, don't go," she said, as he made for the door. "I didn't mean to offend you."

"Oh, I'm not offended," he replied, "I'm going for more flowers."

Rocket Reviews

by Paul LaViolette, E.E. '55

THE MARS PROJECT

By Wernher von Braun
University of Illinois Press,
Urbana, Illinois, $3.95

Based on "Das Marsprojekt," a special issue of the magazine "Weltraumfahrt" published in Germany in 1952, the "Mars Project" is a fitting companion volume to "Space Medicine."

It is in this book that the dream of space travel forms into a tangible reality, not in the fanciful elaborations of the science-fiction writer, but as the cold calculations of a scientist.

Mars is the target of this particular edition, but there is no doubt that it could well be any other nearby solar satellite, the general equations and theories are that flexible. The Mars trip according to Dr. von Braun will take 70 men in ten ships 2 years and 239 days. Of this time 449 will be spent circling Mars.

Three "landing boats" will be provided to land 50 of the men for a period of approximately 400 of the 449 days. The "landing boats" will have large wings for a half-powered, half-glide descent to the planet. One boat will be equipped with skiis and will land on one of the polar caps. It will then be abandoned and all supplies loaded on vehicles to be transported down to the equator and a landing field made for the remaining two wheeled boats. After exploring for more than a year the boats will return to the orbiting rockets and the expedition will return home in seven of the original ten rockets.

Except for the innovation of the "landing boats," which in reality are single tage rockets, Dr. von Braun follows the conventional theory of suggested space travel. Three stage rockets (approximately 46 of them) will erect a satellite station 1075 miles above the surface of the earth. It is from the satellite station that the actual Mars expedition will leave, unhampered by the comparatively enormous grip of gravity on the earth's surface.

Throughout the book von Braun's calculations back up his theory to prove that the project is at least technically possible. Some of the formulae are rather generalized it is true, but only to give a clearer picture. Actually, the expedition would take calculations and logistics far larger than presented in this thin volume, but Dr. von Braun says that the "requirements for a large elaborate expedition to Mars are no greater than those for a minor military expedition extending over a limited theater of war."

Dr. Wernher von Braun was brought to the United States in 1945 by the Army from Germany after having gained renown for his part in developing the V-2 rocket. His articles on space travel have gained wide recognition. Several of these have appeared in Collier's. (Reviewed by Paul E. LaViolette)

* * *

SPACE MEDICINE

Edited by John P. Marbarger
University of Illinois Press, Urbana, Illinois
Cloth $3.00, Paper $2.00

With the omnipresence of space conquest ready to become a reality, man is discovering that the greatest unknown quantity facing him in his conquest of the stars is the human factor.

In March of 1950, a symposium was held at the Professional Colleges of the University of Illinois in Chicago. There experts in the fields of science closely related to this problem assembled to participate in discussions and present papers on the subject. This book is the direct result of that symposium. Six papers are presented by scientists that attempt to show how interplanetary space travel is expected to affect the human body. The discussions range from possible chances of life on the surrounding planets to the harmful effects of cosmic rays and X-ray radiation.

There are many questions which puzzle the scientists. What will be the effects of the absence of gravity? Of the tremendous accelerations necessary to escape the gravitational pull of the earth? Of the loneliness in the void and its effect on the mind? Add to this the heat and cold extremes, the deadly radiations, the constant need of the normal body of oxygen, water and food, and the question of man in space becomes more and more difficult.

Three of the scientists, Drs. Hubertus Strughold, Heinz Haber, and Konrad Buettner are associates in the Department of Space Medicine, USAF School of Aviation Medicine, Randolph Field, Texas. It was with the vision of the coming of space travel that this Department was organized. Two more are Major General Harry G. Armstrong, USAF (MC) the Surgeon General, and Paul A. Campbell, Colonel (MC), USAF (Reserve). The sixth member is perhaps the most well known and controversial figure in the rocket field today, Dr. Wernher von Braun of the Guided Missiles Development Group, Redstone Arsenal, Huntsville, Alabama.

It is Dr. von Braun who perhaps best sums up the need for more serious study of man in space with the ending of his paper: "The time has arrived for medical investigation of the problems of manned rocket flight, for it will not be the engineering problems but rather the limits of the human frame that will make the final decision as to whether manned space flight will eventually become a reality." (Reviewed by Paul E. LaViolette)

The Anchorage-Tok Junction telephone line, built through frozen wilderness, passes near Alaska's Mantanuska Glacier. It connects with facilities to Fairbanks.

The line is through to Tok Junction, Alaska

Ever hear of permafrost? It's sub-surface earth, permanently frozen hard as rock. But it was only one small problem in pushing through Alaska's newest telephone line

As the nation's defense perimeter was pushed northward, it became plain that high-speed communications were needed for Alaska. The Army Signal Corps asked the Bell System to help build a modern telephone line for our strategic northern outpost. Today the line is a fact.

But the 330-mile route between Anchorage and Tok Junction on the Alcan Highway called for all the resourcefulness and skill of Bell System and Army engineers.

What type of line? Engineering studies and surveys proved that weather, expense and maintenance problems made it impractical for the new line to be aerial or buried cable or radio relay. The answer was open-wire pole line plus carrier equipment. But stringing this line through frozen wilderness was rough business.

The line had to cross two high mountain ranges. Average spacing between poles was 155 feet, but to bridge rivers, ravines and steep mountainside descents called for long-span crossings, ranging from 400 to 1800 feet.

Getting the right vehicles, tools, and materials to the right places when needed was a major feat of planning in this wilderness. The line called for 15,000 poles of varying lengths, 2500 crossarms, 1,325,000 pounds of copper-steel wire and 2400 tons of hardware.

Dynamite licks permafrost. Bulldozers, pole-hole diggers and big trucks battled their way over tortuous mountain roads. The simple process of setting poles proved almost impossible in some areas because of a volcanic silt hardened by permafrost. No drill was tough enough to withstand its pumice-like action. The problem was licked by punching holes and using small dynamite charges.

But now the work is done. Engineers have turned their talents to other parts of the vital communication system—building a long distance dial switching system between Anchorage and Fairbanks.

And so it is with the fast-growing telephone company. There always is a new frontier to conquer—in research, at the Bell Laboratories, in manufacturing at Western Electric, or in one of the operating companies serving the changing requirements of a constantly shifting population. Check now with your Placement Officer on the opportunities which await college engineers in the Bell System.

BELL TELEPHONE SYSTEM

THE MOON IS BLUE

by Don Arnold, E.E. '55

Nearly as long as man has been on earth and has been able to raise his eyes to look to the great bowl of jewels in the night sky above, he has dreamed of someday freeing himself of the grip of our mother planet and rising to explore those jewels. Now, scientists are on the threshold of realizing mankind's age-old dream, via a space station in the sky. There are various types, but in this article, only the rocket driven satellite will be discussed.

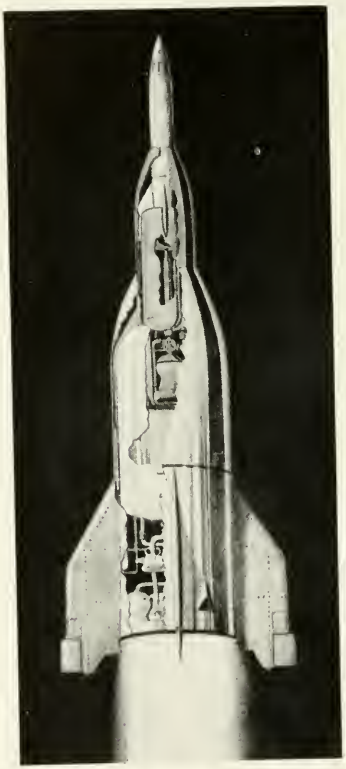
The earth lies at the bottom of a whirlpool, which is the pull of gravity holding everything to it. Our advantage of savior lies in the fact that this pull diminishes as we move farther out from the earth, and that a body to move in a circular path must be accelerated toward the center. To raise ourselves out of the depths of this tremendous whirlpool is the job of the rocket scientists; to keep us up revolving around the earth is the job of Nature.

The part that Nature plays is very simple. When a weight is swung on a string, the string pulls the weight towards the center, thus making it revolve in a circle. We do not have a string attached to our space station, but something much better—the gravitational pull of the earth. If you remember from physics the formula for the force between two bodies, $F=Gm_1m_2$ over R_2, and the formula for the force needed to pull a given mass in a circle, $F=mv^2$ over R one has the key to the solution. We set the two equations for force equal, and can thus determine the velocity with which our space station must travel at any desired height. From this we find that $v=\sqrt{Gm}$ over R, where G is a constant, m is the mass of the earth. Remember that our station is not free of the influence of gravity, but is pulled toward the earth by it to make the station revolve in a circle.

Once outside the greater part of the gravity of the earth, the rocket can be steered and propelled by very small forces. But to escape from this entwining grasp with which our mother planet holds us, we must attain the enormous speed of 25,000 mph at a very early stage.

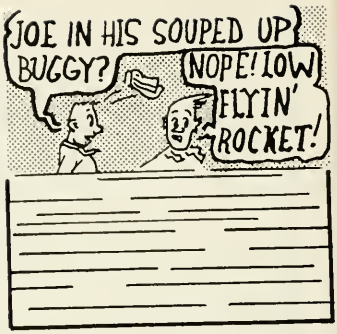
Now we come to the part played by the rocket men to get the rocket out of the depths of the gravity ocean. They agree that no single-stage rocket can make this escape—that some other device is needed. Thus the resourceful rocket men have come upon the idea of the multiple-stage rocket. But here the experts disagree as to how many stages are needed. The most optimistic place their hopes on a two-stage rocket, while the majority of their colleagues are sold on the three-stage rocket. The main drawback to this colossus is its necessary gigantic size. As big as the Statue of Liberty, this rocket would weigh 7,000 tons, stand 265 feet high, and be equipped with 51 rocket motors, having a combined thrust of 14,000 tons which is the equivalent thrust of 6,000 modern jet fighters. This behemoth would be able to transport into space the meager pay load of only 36 tons.

This three-stage rocket will be fired from the equator so as to have the added



A cut-away diagram of a three-stage rocket showing the fuel compartments, and engines.

push given to it by the spinning earth. With this 1000 mph starting speed with which the earth's equatorial belt revolves, the rocket will begin ascending with an acceleration of 1 g. This is



as fast as a freely falling body would increase its speed. Since the thrust remains the same, and the rocket becomes lighter as the fuel is used up, it quickly attains an acceleration of 9 g's.

The motors continue to fire for 84 seconds, burning 5,250 tons of fuel. By this time, the rocket is moving virtually horizontally and has reached a height of 24.9 miles and a speed of 5,206 mph. Here the first stage is detached and falls back to earth. The second stage, weighing 990 tons adds its 1750-lb. thrust for 124 seconds to push the rocket to 39.8 miles and a speed of 14,364 mph.

Now we come to the payload section of our rocket—the winged third stage containing crew, controls, and equipment. This all-important "nose" weighs 143 tons and uses its motors to reach an altitude of 63.3 miles and a speed of over 18,000 mph. The rocket has now reached a speed sufficient to spiral upward in an elliptical orbit to the height where it can circle the earth—1000 miles above the surface. Everything up until this stage has been operated automatically, but now the crew must make rapid calculations and changes in the course of the rocket to correct all the errors encountered on the trip. The crew turns on the motor for 14 seconds, turns the ship into its proper heading, and sets the speed at the necessary 15,840 mph. The satellite is now in its orbit, and the crew is ready to face the feeling of outer space. Getting to our orbit will be a problem in itself, but living there is the most bizarre problem of all. As yet many of the problems remain unanswered: how to keep the blood from boiling in the rarified atmosphere; how the extreme differences in temperature to be encountered; what effect will solar radiation have on the human tissues. These and other questions are before the doctors before the rocket can add another moon to the night sky. But once up above the earth, where do we go from here—the moon, Venus, Mars, the outer planets? Who knows?

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PIER PILINGS

by Bob Walker, E.E. '56

TELEPHONE ON WHEELS

Have you ever thought, Mr. Average American, that perhaps someday you will be able to walk over to your telephone and place a call to someone, even though he is driving his car?

Actually, telephone service to or between moving vehicles is already in widespread use in localities which find it both useful and practical. Common Carrier Mobile Radio-telephone Service, as it is officially known, is primarily useful for the following situations:

(1) Providing telephone service to water-separated points.

(2) Providing service to vehicles and boats.

(3) Providing service where cables are impractical.

(4) For replacing or supplementing cables at substantial cost advantage.

Radio systems had been used to only a limited extent for many years until 1945, when the Federal Communications Commission allocated several new bands for certain types of service. This enabled telephone companies to use radio to extend service to mobile subscribers.

There are six types of radio service for which the FCC will grant licenses to telephone companies, namely:

(1) Long-haul, toll radio channels.
(2) Short-haul, toll radio channels.
(3) Urban mobile radio service.
(4) Highway mobile radio service.
(5) Rural subscriber service.
(6) Special services. (Emergencies, etc.)

A long-haul toll radio link is a means for communication between fixed points involving the use of one or more intermediate stations. A short-haul link is a means for communication between fixed points, but not needing intermediate stations due to the proximity of operation. Two types of mobile service have been established. Urban service is furnished to vehicles operating in or close to a given city. Highway Mobile service is rendered to vehicles moving over the principal highway of the country. Highway service is more involved than urban service, since more than one transmitter is required.

Prospects for mobile radio-telephone service are almost unlimited. Radio-telephone could almost entirely replace dispatching stations for delivery and trucking companies, express and freight pick-up trucks, laundry, dairy, bakery, and meat trucks. Taxicab companies are already using radio communication to dispatch cars. Garage and wrecker trucks could always be on the spot through the use of radio-telephony. Doctors would find this an invaluable service during emergencies. Newsmen could keep abreast of the latest happenings through mobile communication. Ambulances would find the same use for this service as doctors. Cars of police and fire chiefs, and important public officials might well be advantageously equipped with radio-telephone. Switch engines in railroad yards need never stand idle while the engineer receives orders if the cab is equipped with two-way radio communication. Contractors and highway engineers could always kee pin constant communication with one another while working on some huge construction project. Radio, television, and appliance service calls through the use of mobile telephone. Boats and trains are also important prospects for this new service. As you can readily see, the door has been opened to a new field, both vast and extensive.

Several types of mobile service are being offered. These are:

(1) General service—between a regular telephone and a mobile unit or between two mobile units.

(2) Dispatching service—furnished between a designated customer and a given fleet of mobile units on a commercial basis.

(3) Signalling service—a one-way paging system from fixed telephone to mobile unit.

The frequencies assigned to telephone companies under present proposals lie in four principal bands—(1) 35 to 44 mc. (2) 152 to 162 mc. (3) 458 to 460 mc. (4) 900 mc and over. Because of the increasing demand for channels by miscellaneous interests, such as police and taxicabs, it seems unlikely that bands 1 or 2 will be used extensively.

The radio equipment used in the telephone field is classed as to its usage as: (a) Fixed station (with respect to location, used to communicate with other fixed stations or mobile units), (b) Relay stations (used as intermediate stations in point-to-point links or in connection with a mobile network), and (c) mobile stations (primarily automobiles and trucks).

The equipment used in mobile units consists of an FM received, an FM transmitter with a power output of from 7 to 30 watts, a fender or roof-top antenna, and a telephone handset. The storage battery of the vehicle is also con-

sidered to be part of the mobile installation.

Mobile service, because of cost and limited spectrum space, must usually operate on a party-line basis. As many as 100 mobile units could be placed on the same channel. By keeping conversations brief, adequate service could be maintained without undue interference.

It is desirable, though not essential, that some means be used for selectively signalling mobile subscribers. Signalling can be accomplished by utilizing selective code-call units, operating in conjunction with the received. Code-call units are available in two types, the secret and non-secret conversation-type.

In the secret system, only the mobile unit initiating or receiving the call can hear or talk over the channel. While the call is in progress, the transmitters and receivers of all other units on the same channel are rendered inoperative. A busy light in each mobile unit shows when the channel is in use. In the non-secret type of service, any mobile subscriber can, of course, listen in on any call. This is the more common type of service.

Transmitter power requirements are difficult to generalize upon. Experience has shown that 7 to 30 watts of power is adequate for mobile units, when used with a central office transmitter of from 50 to 250 watts rated output. Mobile applications require non-directional antennas, as a mobile unit may move in any direction.

Mobile system operation is as simple as placing an ordinary telephone call. The mobile subscriber picks up the handset and observes the busy light to see if the channel is in use. If the channel is not in use, the subscriber presses the "push-to-talk" switch on the handset. This places the transmitter carrier on the air, and it is picked up by the fixed station and relayed to the mobile service operator, who plugs in the mobile service jack, placing the central office transmitter on the air. The operator then asks for the called number. The call is then completed in the usual manner. The mobile subscriber must, of course, press the handset switch when speaking, and release when listening. If the call is to another mobile unit, conversation is on a "push-to-talk" basis on the part of both subscribers.

Rural subscriber radio-telephone service utilizes links between the central office and distant rural telephones. It is of particular usefulness where wire lines would be economically unfeasible. An experimental Bells System project furnishing radio-telephone service to eight ranches lying at distances of 11 to 21 miles southeast of Cheyenne Wells, Colorado, was installed in 1946, and has been in successful operation since.

EYES OF THE CITY

by **Bob Walker, E.E. '56**

Chicago's traffic control has gone modern! Electric "eyes" are now being used to co-ordinate city traffic lights with Chicago Transit Authority elevated trains operating at a temporarily established street level.

The Garfield Park elevated service had previously been operating over elevated tracks which were directly in the path of the Congress Street Superhighway. The tracks were left standing as long as possible, until September, when work had progressed to the point where the red structures had to be taken down. In order to provide service, the only solution was to initiate temporary street-level operation. Building new tracks would be unfeasible, since final plans called for operation of the electrified line directly in the center lane of the highway.

Tracks Parallel Street

The new right-of-way occupies a fenced-in area on the south side of Van Buren Street, between Racine and California Avenues. Inclines at these points carry the trains to the remaining elevated structures which will not be removed. Since the tracks occupy half the the street, traffic had to be directed one-way; west-bound was chosen.

Originally a total of twenty-four streets crossed the right-of-way. Of these, fourteen are now closed to pedestrians and vehicles. The other ten, considered impractical to close, have been equipped with electronic signal control devices at each intersection.

"Eyes" Guide Stoplights

This is how the new electronic signal system works. Each intersection is provided with four standard traffic lights, two special lights for train motormen, and four sets of electric eyes, two for west-bound service and two governing east-bound.

As a train approaches an intersection, the motorman is instructed by a large octagon sign to "STOP HERE!" The train thus halted at the stop sign breaks the light beam cast obliquely across the tracks by the electric eye. This holds the street traffic lights at red until the train clears the eye at the opposite end of the intersection. Immediately beyond the "STOP HERE!" sign is the train traffic signal providing these changing aspects: RED—indicating STOP and WAIT; RED, with word ALERT—indicating prepare to start; and YELLOW—indicating proceed with caution.

Street traffic lights with standard red, yellow, and green signals control vehicles and pedestrians at all intersections.

Signals Automatically Timed

In order to provide maximum operating safety at minimum delay to transit service, the train signals are timed to operate automatically on cycles of sixty-four seconds, with two exceptions. The sixty-four second cycle is sufficient time for a train to travel from one intersection to the next in time to receive a yellow signal, under normal conditions.

The motorman must bring his train to a complete stop at each intersection and wait for the yellow signal to appear in the sixty-four second cycle, before proceeding across the intersection. When the yellow light appears, street traffic lights show red for north-south traffic and green for west-bound.

Only one more problem had to be solved: how to prevent west-bound motorists from making left turns across the right-of-way on a green light with resultant collision. Solution to this is simple. Each corner is now displaying a "NO LEFT TURN" sign for west-bound traffic.

Train Speed Governed

Trains descending inclines to the street level are governed by automatic time-controlled block signals. This feature not only prevents a train from receiving "proceed" indications, but, by means of track trips, brakes the train if it is operating above proper speed limits.

Large yellow signs with a black "T" indicate entrance into these time-controlled areas to motormen. Other signs indicate proper train speed.

Running Time Increased

The street-level operation is approximately two and one-fourth miles long and increases running time in the morning rush hours about 11½ minutes. During midday, the increase is 13 minutes longer than former schedules.

When the Congress Street Superhighway is completed, Garfield Park service will be provided by a fleet of all-new metal transit cars operating in the middle lane of the highway at speeds of sixty to sixty-five miles per hour. It is anticipated that this high speed service will be inaugurated in 1956.

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A Statement on . . .

Science Fiction

by Maurice Garnholz, Aero.E. '56

Since the end of World War II, a seemingly new field of literature has risen to the attention of the general public. Before that time only a small number of people knew that this type of writing—labeled loosely as science fiction—even existed. But with the advent of new examples of scientific progress like electronic calculators, rockets, and the atom bomb, all which were brought about largely by the war, the ranks of followers of science fiction grew swiftly, until today the number of people who have not at least heard of it is dwindling rapidly. Large write-ups in magazines (including *Life*) have publicized this literature extensively. More and more books, movies, and radio and television programs about science fiction are being brought forth.

But even with this tremendous surge of popularity, science fiction (or scientification as it is sometimes called, STF for short) is still a vague term in the minds of most people. It is often thought by the uninformed that science fiction

MAURICE "MAURY" GARNHOLZ has been with the staff of the Illinois Technograph for one year and is at present assistant editor. Maury's home is Hoyleton, Illinois, and his curriculum is aeronautical engineering from which he will graduate in 1956.

is merely juvenile trash written by some eccentric writer in his spare moments while in dire need of some ready cash. This concept is even more wrong than the also false belief that these stories deal only with swashbuckling tales of speeding rocketships or a crazy scientist intent upon completely erasing the earth from the universe. Although stories dealing primarily with interplanetary and interstellar travel do abound in various forms throughout science fiction literature (and it is now classified as a literature), an extremely wide variety of other subjects is present also. Such topics as bio-chemistry, the future, psychology, time-travel, mental difficulties, robots, thinking machines, sociology, mathematics, semantics, language and race difficulties, governmental utopias, and many others are discussed, set to theory, and are essentially the main settings of the stories. Very few fields are left untouched by science fiction authors. It is doubted very much if any other designated field of literature encompasses as many different things as does science fiction.

By far the most of science fiction stories are primarily novels with scientific settings. They usually concern events that could very possibly happen to anyone of us if we were transported to a future or special situation. The best plots are those which have some sort of unconventional theory at the climax or as the entire basis for the story. This fact is probably one of the primary reasons for the popularity of science fiction. Only there can you find seemingly fantastic and daring theories and ideas. Almost any other publisher would not dare to print such seemingly unconventional writing. In science fiction, as the name implies, the theories and ideas are put into practice via a fictional plot. The fact that very fantastic ideas can be written with little fear of undue criticism from the readers encourages many new ideas. Thus, many new and hithertofore unseen conceptions are brought to light. In time many of these fantasies become facts; *e.g.*, rockets, flying saucers, television, and the atomic bomb are only a few of the many things written about on the pages of science fiction magazines before they became a reality.

If many of the ideas put forth in science fiction stories still seem to be too much of an impossibility or improbability for the average person, let him remember that sixty-five years ago automobiles were unheard of; twenty years ago television was nonexistent; forty years ago airplanes were laughed at; twenty years ago rocket travel was unthought of, except by, perhaps, a very select few. Who can say what the future has hidden from our prying eyes? Who is qualified to state that the science fiction writers are wrong and too daring? At about the time of the Civil War, or immediately prior to it, the head of the United States Patent Office resigned, because he believed that everything worthwhile had already been discovered or invented. Science fiction states nothing as being definite. It merely surmises as to what would happen if a certain condition(s) were true.

Although many read science fiction primarily as a source of escape literature which takes them away from the trials and tribulations of our civilized society for a short while, the majority read it also for the interesting theories and new conceptions of old ideas. These readers are not abnormal juveniles or psychopathic adults. On the contrary, an above average intelligence is required to comprehend many of the scientific abstractions, theories, and ideas brought forth in many of the stories. Numerous scientists, engineers, astronomers, and other men of reputed intellect peruse much science fiction literature.

Likewise, many of them compose an impressive portion of it. Dr. John R. Pierce, an electronics expert with Bell Telephone Laboratories, writes fantasy and science fiction in his spare time. So do many other scientists, including Robert S. Richardson, astrophysicist of the Mount Wilson Observatory; George O. Smith, Emerson Radio engineer; Isaac Asimov, a Boston chemist; John W. Campbell, Jr., an M. I. T. alumnus who edits *Astounding Science Fiction*, one of the best known magazines in the field; L. Sprague de Camp, aeronautical engineer during the last war; and Emory Lakatos, lawyer and brilliant mathematician. Robert Heinlein, most popular of science fiction writers, is a Naval Academy graduate. Willy Ley, well known rocket specialist, writes technical articles for both science fiction and other magazines.

As in the latter case, the word "science fiction" on the cover of a magazine is often misleading, for many factual and truly scientific articles are present between the covers. There can be little doubt that the popularity of science fiction is steadily increasing. Science fiction may be only a passing fancy, but if so, it is passing because the fiction is becoming reality.

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RADAR and Your Weather Report

by Alan England, E.Physics '54

During the Second World War and the Korean War, radar was primarily thought of as a military weapon in that it could be used to observe the motion of distant ships, planes and equipment, and often to determine if such objects that appeared on the radar "scopes" were clouds which were more often considered nuisances rather than useful

ALAN ENGLAND, one of the new members of the Technograph staff this fall, is a senior in engineering physics. Alan expects to graduate this June.

information. Only a general idea of future weather or weather over some strategic target could be made since the science of radar weather prediction had not developed to such a point that these estimates had much value. The day is finally coming when short range weather predictions can be made with great accuracy—such accuracy possible only thru the use of radar.

Principles of Radar

In order to acquire some conception of how radar is used in weather prediction, perhaps we should try first to acquire a qualitative picture of how radar operates. The action is roughly as follows. A very high frequency oscillator in the radar transmitter is allowed to oscillate for a very short period of time. The nature of the oscillation is such that wires cannot be used to guide the signal to a suitable antenna. Hollow metal tubes known as waveguides direct the signal to the antenna. The antenna, by the use of a reflector, usually referred to as a "bedspring" or a "dish," directs the radiation along some particular azimuth in some particular pattern in space. Ordinary radar waves are so short that, unlike radio waves, they would fly off in a straight line into space except for their one desirable feature. This feature is simply the fact that many materials can reflect radar waves to such a degree that the reflections or "echos" can be picked up at the same point from whence they started. While the pulse of energy is leaving the antenna, leakage of the signal thru the structure blocks any returning signal, but after the outgoing pulse terminates, any reflected radiation can be picked up by the same antenna and channeled by waveguides back to a radar receiver.

The receiver so shapes the reflected signal that it can cause a pattern on the screen of an oscilloscope. The time necessary for the radar signal to leave the antenna and return depends on the distance between the antenna and the object that reflected it. The "scope" can be so calibrated that this corresponds to some specific distance on the scope and can be measured in miles. Objects vary in their ability to reflect the energy of the signal, metallic objects being the best reflectors, but the size and nearness of the objects also affects the amount of signal reflected back to the antenna.

Since a cloud is a fairly large object, containing a large amount of material, water, it is able to reflect a large amount of signal back to the antenna.

The Meteorlogic Laboratory

At the Meteorlogic Laboratory, located at the University of Illinois Airport, the use of radar is undergoing extensive testing along with a number of other experimental devices all falling under the classification of instrumentation for studies in cloud physics. This project is sponsored jointly by the signal corps, the state of Illinois, and a subcontract through the University of Chicago with the Air Force. The group leader, Glen Stout, is with the state water survey. The project is studying such phenomenon as charge formation in the air, the conductivity of the air, the electric field set up in the air by this charge formation, the effect of drop size and intensity of rainfall on the signal received by the radar antenna, and the effect of the number of sodium particles in the air on the formation of clouds.

One interesting check on the radar is a dome camera which is used to determine the fraction of the sky that is clouded. A silvered hemisphere is placed flat side down on a platform and a camera is suspended over it. The photograph taken by the camera shows the entire sky at once and thus the amount of cloudiness can be determined and compared to that seen by the radar set. A sodium particle counter is in operation which uses dishes of some jellied material. The dishes are exposed to a certain quantity of air. Later analysis shows how many sodium ions per cubic foot exist in the air. This information is particularly valuable near coastal regions where it is known that such ions, originating from the ocean, act as condensation nuclei for water droplets. The

Radar antenna used with the range height indicator scope. This antenna can move in a forty degree vertical arc along any desired azimuth. (Photo courtesy Illinois State Water Survey)

effect of such ions on condensation inland has not been determined, but this present study is expected to yield some interesting results.

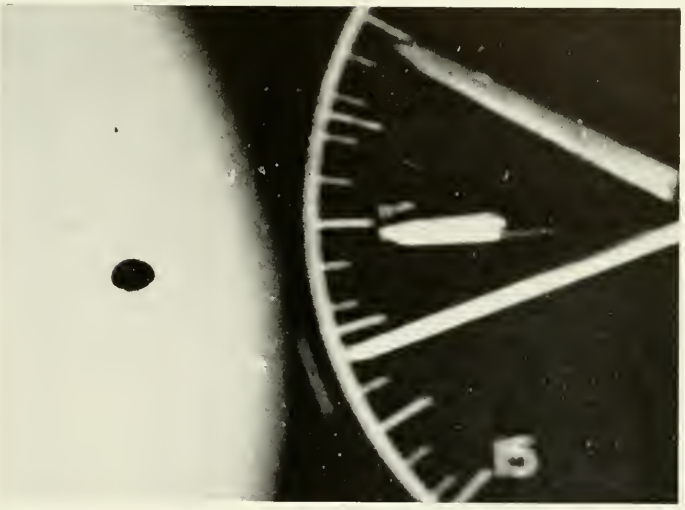
It has been found that the effect of drop size on radar reception has been the worst difficulty in so far as accurate measurement of rainfall is concerned. Analysis shows that, roughly, the quantity of radiation reflected is proportional to the sixth power of the diameter of the rain drops. However an equally important factor is the shape of the drops—ideally spherical or a shape that reflects less radiation. It is also known that ice particles in the form of snow, sleet, and hail do not reflect as much energy due to the fact that they are not usually spherical. The Meteorlogic Laboratory uses a high speed camera to photograph the drops during rainstorms. Pictures are taken every few seconds for the entire length of the storm in order to give a large enough volume of rain so that statistical methods may be used. While, as hoped, no relation between raindrop size and intensity of rainfall, *i.e.*, the number of inches per hour, has been found, it is believed that specific types of weather, such as thunderstorms, cold fronts, and warm fronts, individually affect the size of the drops. Before the advent of the high speed camera, drop size was determined by allowing the drops to fall on a pan of flour onto a sheet of absorbent paper. In the former method, the size of the ball of flour produced determined the size of the drop; in the latter method, the area of stain determined the size of the drop. In both methods the measurement was very rough and had the disadvantage that the shape of the drop was still unknown.

An area of about ninety-nine square miles located some thirty miles north and west of the airport is used to study the ability of radar to determine the intensity of rainfall by energy methods. This area was supplied with fifty rain gauges to check the radar measurements. This area is marked on one of the oscilloscope faces at the Laboratory. When preciptation occurs in this area, a phenomenon that can easily be determined by the brightness of the scope image, a small light sensitive vacuum tube goes into action and records the area of brightness by means of a digital area integrator. The brightness of the image is determined both by the intensity and the drop size of the rainfall, factors which the integrator can compensate for.

Radar Equipment and Techniques

The design of a radar set for use in observing weather phenomena is necessarily a compromise of many features. For best reception of rain clouds at large distances a narrow beam width of the signal is desirable. The size and weight of the antenna necessary for such a beam width is the principal factor here, for the wider the "bedspring," the narrower the beam can be made. However, the bigger the antenna gets, the more weighty it becomes, necessitating stronger structures to withstand the added strain. Long range is necessary for adequate forecasting along with as little attenuation of the signal strength as possible. This consideration adds to the size and complexity of the electronic apparatus itself along with the power requirements for such clear reception. The wave length of the radar signal to be used is an additional problem. A very short signal wavelength produces very fine detail but is easily attenuated. Such a wavelength will clearly show nearby clouds in great detail but will fail to indicate the presence of any clouds behind them. The controlling factor behind all of the above considerations is the cost of the equipment, which is directly related to the range, detail, and accuracy necessary for a particular installation.

There are usually three types of indicating oscilloscopes associated with any weather radar installation. One, the Plan Position Indicator or PPI scope actually produces an image, as if viewed from above, of a large area around the antenna as the center. A rotating antenna is used with this scope that sweeps out a complete circular area around the antenna every few seconds. The scope sweep, the magnetic field that moves the electron beam in the oscilloscope tube across its face, is produced by two electromagnets that rotate around the tube in phase with the rotation of the antenna. The effect of this operation is to produce a pattern on the scope which is brightened by the passing of the sweep and which depends upon the persistance of the phosphor of the oscilloscope to maintain the image after the sweep has passed. Another scope, the Range Height Indicator or RHI, indicates the height above ground of the various cloud formations at any particular azimuth. For this scope, an antenna that bobs up and down along any particular azimuth is used. The scope sweep does a similar operation, so that the scope face shows an image of the cloud formations as viewed from the ground, however with a much expanded vertical scale. The third type of scope can take a particular area seen by the PPI scope and expand it to give great detail. This scope, which also gives a picture as if viewed from the ground, is put into use when the rotating antenna is stopped and faces a particular direction.



High speed photograph of the largest raindrop observed at the Meteorologic Laboratory. This drop measures 10.4 by 7.6 millimeters.

Observational Techniques

The human observer at the radar scope must be able to interpret the signals he receives with skill since radar tends to emphasize some phenomena while minimizing others. Since all the observer of the scope (or of photographs of it) has as indications of weather conditions is just the relative brightness of the image, misinterpretations can arise. A small thunderstorm may give a much larger signal than a similarly shaped cloud precipitating snow. In general, rains with large drops give larger signals than heavy rains with

smaller drops. As mentioned before, ice, snow, sleet, and hail will give only one-fifth the return signal that most rain will produce. Heavy, non-precipitating clouds will tend to shield weather conditions behind them while clouds precipitating snow will not cause nearly the same signal attenuation. For large objects, the signal strength returned is roughly proportional to the reciprocal of the distance squared between the antenna and the object. This return signal strength occurs with the object occupying the whole width of the beam as the beam passes it. A small object, on the other hand, will return a signal strength approximately proportional to the reciprocal of the distance to the fourth power. Buildings in the nearby area can block off areas of space if they are taller than the radar antenna. Buildings can also reflect the signal going out and coming back so as to produce cloud images in parts of the sky where they do not exist. The magnitude of the received signal is also proportional to the square of the wavelength, so that higher frequencies produce less return than the lower frequencies. The usual range for most radar sets when transmitting over land is less than seventy-five miles, while over water the range is greater than one hundred miles.

Results

While radar is a very useful tool, it is still in the experimental stage in so far as weather prediction is concerned. It can only achieve full usefulness when used with the usual maps and charts employed by the weather men—surface synoptic charts, upper air charts, and adiabatic diagrams. Its ability to produce an extremely detailed three dimensional precipitation pattern thru thousands of cubic miles has made it particularly advantageous in indicating the stability of air masses, the freezing level of clouds, the presence of vertical convection currents, the motions of clouds, and the degree of overcast in small areas. Its most practical application at the present time is in conjunction with airfields where it can indicate roughly the wind speed at high altitudes, the visibility near the airport, and the ceiling at the airport.

FIG. 1 RADAR PPI PHOTOS WITH 10-MILE RANGE MARKERS; ILLUSTRATING TORNADO DEVELOPMENT ON 9 APRIL 1952

ILLINOIS STATE WATER SURVEY

Radar PPI photographs of the tornado that passed by Champaign-Urbana last April. The long tail projecting from the cloud is the funnel of the twister.

An accurate estimate of the present abilities of radar in the field of rainfall measurement can be made by observing that while, at the present time, there is in the United States about one rain gauge for every four hundred square miles of territory, the use of radar has indicated that if applied extensively, this figure could be reduced to a rain gauge or its equivalent every two hundred square miles.

It is not difficult to imagine that the future potentialities of "radarized" weather prediction, coupled with the other possible advances in the field as mentioned here, may well advance the accuracy of weather prediction to the idealized one hundred per cent mark so much desired by the picnickers, and the baseball fans of the world.

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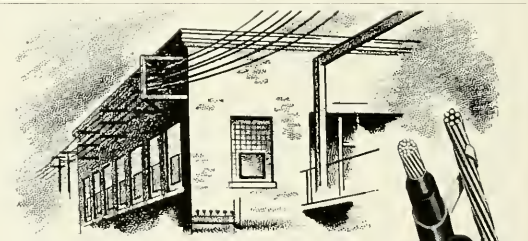

How to lick dust, moisture and acid fog

prevalent in the atmosphere surrounding the Rumford, Me., mill of the Oxford Paper Company posed a problem in power circuit maintenance. The combination of these elements caused wooden structures and even over-voltage insulators to become conducting, resulting in phase-to-phase flashovers and burndowns when ordinary overhead wires were used.

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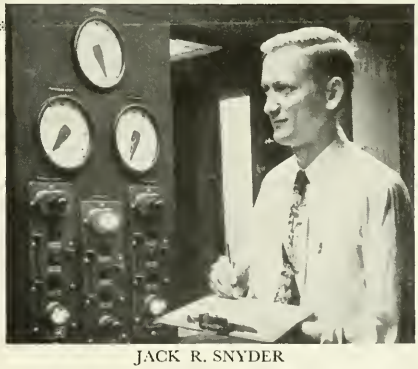

JACK R. SNYDER
Design Engineer—Helicopter Engineering Division
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The Fi
Illini

compiled by Howa

Every football team has its own team of strategists. Here Illini coach Ray Eliot checks the situation during a game.

End Rocky Ryan (83) moves down
Cook (25 of Stanford close on his

Illinois' speedster, J. C. Caroline (27) rolls around end for a gain against Stanford, but Stanford's Jerry Gustafson (19) tries to slow him down a bit.

Everyone's after that elusive footb
a poss to Rocky Ryan (83) in the I

Photos by Daily Illi

ghting '53

adler, Ag.E. '55

after snagging a pass, with Ron

s Elry Falkenstein (12) attempts
Stanford contest.

tc photographers

Illini football captain Bob Lenzini (62) greets the captain of the Stanford Indians, Norm Manoogian (60) before the Illinois-Stanford game.

The Illini football team charges onto the field prior to the start of the Illinois-Minnesota game. Identifiable players are Paul Furimsky (89), Gus Mackris (73), Dick Rosenberg (31), Hugh Woodson (46) and Ron Yochem (50).

Richard J. Conway, Lehigh '51, selects Manufacturing Engineering at Worthington

RICHARD CONWAY checks cutting tool with machinist before milling a pump casing.

After completing his general training which brought him in contact with all departments, Richard J. Conway decided that manufacturing engineering was his field. He says, "I chose the Manufacturing Engineering Department after completing my general training at Worthington because as a graduate in Industrial Engineering I can learn the practical aspects of my field while applying theory I learned in college.

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STANDARD

by Tom Brody, M.E. '56, Donna Rudig, E.Physics '57
and Don Kesler, E.E. '56

DEAN WENDELL E. MILLER

Dean Miller came to the University of Illinois twenty years ago after having attended Blackburn Junior College, a work-your-way institution in Carlinville, Illinois. With five dollars in his pocket, he got three jobs for room, board, and cash and continued in this manner until he received his Electrical Engineering degree in June, 1936.

After graduation Dean Miller worked for Northern Indiana Public Service Company and Bell Telehpone Laboratories for five years.

In 1941, he returned to his alma mater as an instructor in the electrical engineering department. During the

war, Dean Miller served as a radar officer for the U. S. Navy. Once again he returned to the E. E. staff and received his master's degree in August, 1946. In 1947 he received his assistant professorship and became associate professor in 1950, at which time he also became assistant dean of the college of engineering.

He was married in 1941 and has two daughters, B'Ann, 10, and Janet Sue, 6. His hobbies are color photography and all types of sports. He once played on a championship high school baseball team, and still thinks baseball is the most scientific of all team sports.

HOWIE HADLER

A familiar face to most engineering students is that of Howie Hadler, associate editor of the Illini *Technograph*. In 1950 he graduated from Rantoul Township H. S., where he had been a member of the football squad and belonged to the band. Howie is also an experienced farmer, having been raised on a farm, and was an active 4-H member for five years.

Howie is in Ag. Eng. and intends to receive his B. S. in February '55. Being active in engineering activities, he is a member of the Engineering Council and is vice president of ASAE, of which he was treasurer last year. And, of course, Howie is one of the mainstays of the *Tech* staff, having joined in his freshman year and being illustrations editor last year. His hobby, when he finds time, is making model airplanes.

Last summer Howie spent an interesting six weeks at the Army R.O.T.C. camp at the Aberdeen proving grounds in Maryland. His future is still uncertain except for a forthcoming two-year army term. If he receives his commission in June he may decide to enter the army then instead of waiting until he graduates. After his army service, Howie has several possible jobs in mind. He is interested mainly in saleswork, public relations, and technical writing or publishing. This last interest stems

BOB LENZINI

The Engineering College proudly introduces Bob Lenzini, a civil engineer, to the students. Bob is a senior in engineering as well as the popular role of the captain of the football team. He is taking the construction option of the curriculum.

This fine product from Waukegan high school is playing his third varsity season this year as captain of the Fighting Illini football team. He says practice from 3:30 until 6 o'clock every evening is not bad after you get accustomed to it.

Lenzini's amazing line play during the 1952 Michigan game caused him to be named "Lineman of the Week" by national sports writers. The critics were almost unanimous in exclaiming "Lenzini was superb."

Bob Lenzini was introduced in the February issue of The Illinois *Technograph*, but since then he has made an addition to the family, a pretty wife, Doris.

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ECMA CONVENTION

by
Martin Goldstein,
Chem.E. '55

Tom Brody of the Illinois Technograph, greets two delegates to the E.C.M.A. convention as they register for the two-day event.

Professor Harry J. Fuller who spoke on "Origin of Cultivated Plants" at E.C.M.A. banquet.

Although our annual convention has been over for two months we still believe we are entitled to toot our own horn a little bit. As an apology (maybe you could call it an excuse) for the article not being in the last issue it can be blamed on the fact that the October issue went to press before the conclusion of the convention.

The 1953 convention of the Engineering College Magazine Associated was held here at the University of Illinois with the Illini Union Building as main headquarters. Opening of the convention consisted of an informal dinner in the Union and a film and smoker Thursday night, September 24.

Actual convention business started on Friday morning with the opening business meeting. Professor John Paustian, retiring chairman from Nebraska, opened the meeting with a greeting to the assembled delegates from schools from New York to North Dakota. In his opening remarks he mentioned the budget of the association and the resignation of the editorial critic for the last two years, Theodore Hayden.

Friday afternoon saw the convention roll into really high gear. At this time

"MARTY" GOLDSTEIN has been on the staff for two years and is attempting to serve as editor-in-chief. Marty lives in University City, Missouri, and hopes to get his B.S. in chemical engineering in 1955.

The panel discussion on illustrations and layout, one of four panel discussions held during the first day of annual E.C.M.A. convention.

discussions were held on matters pertaining to editorial, business, layout and art, and circulation matters.

In the art and layout meeting chairmaned by Professor Bohl, adviser of the *Technograph*, such problems as the system used in putting the magazine together and best effect for reader interest and attention to advertisements were discussed. Also discussed was the problem of "cheesecake pictures" in engineering magazines. Several different views were expressed on this subject.

Editor's note: We of the Technograph would appreciate your views on this subject. Also, if you are in favor of running said type of articles, would you please inform us as to what vein you would like to see the articles in.

Dr. Merk Hobson of the University of Nebraska took charge of the editorial meeting. Main issue discussed was of an idea submitted at last year's convention. This involved asking prominent men in the engineering field for articles to be published simultaneously in all magazines of the association. One of the fruits of this idea was the article by Herbert Hoover (*re Technograph, April* 1953). It has been found that it is exceedingly difficult to get this type of article but work on it will be continued.

Friday evening the banquet was held with Professor Fuller of the Illinois Botany Department as speaker. "Buck" Knight of the Electrical Engineering Department served as toastmaster and Dean Everett of the college of engineering issued a few words of greeting to the assembled delegates.

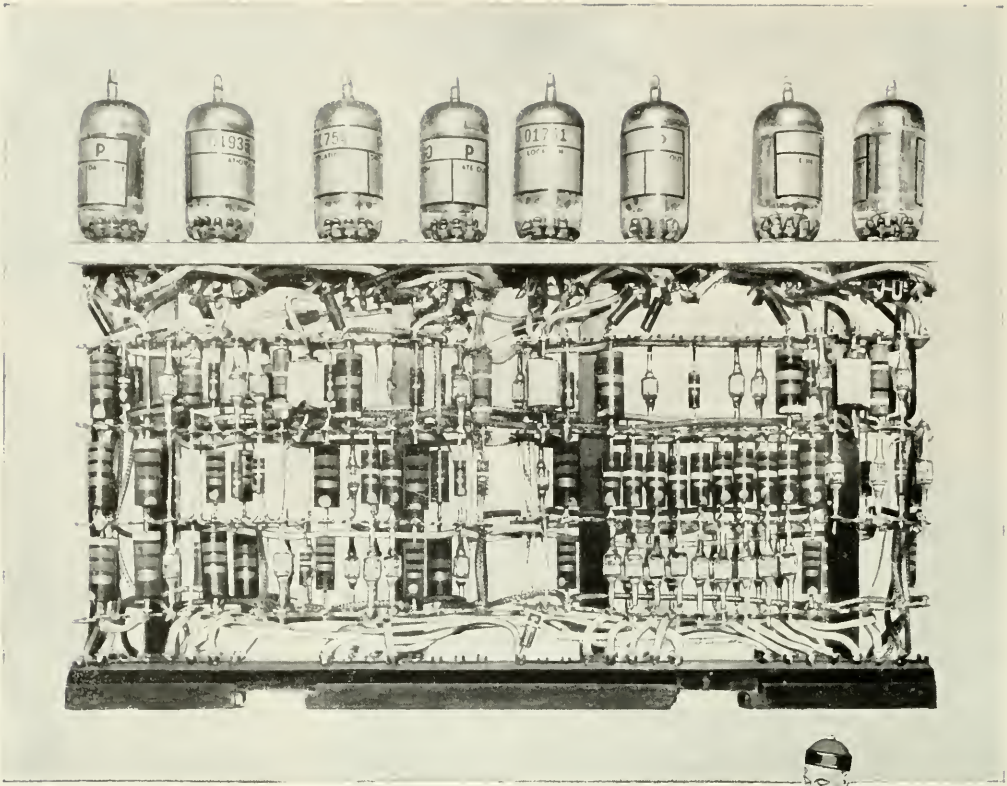
"And a good time was had by all" at the semiformal dance given in the Union Building the last night of the convention. The dance was held from 9 to 12 with music supplied by Paul Kerns and his orchestra.

The main portion of the official business of the convention was taken care of at the general business meeting held Saturday morning. At this meeting the chairman and secretary of ECMA for the next two years were elected. Professor William Farrell of Iowa University was elected chairman and Professor Merk Hobson of the University of Nebraska was elected executive secretary. Thanks were given to Professor Paustian and Mr. Hayden for their work in the last two years.

After the convention most of the delegates adjourned to the Illinois-Nebraska football game in which they sat in their own section.

The group picture of E.C.M.A. delegates to the annual E.C.M.A. convention held on the University of Illinois campus September 25 and 26.

The joint editorial-business panel discussion held during the first afternoon of the E.C.M.A. convention.



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Resembling a Chinese abacus, this 12-inch electronic assembly operates at a speed of one million pulses a second. It is one of 274 similar electronic units that perform the computing and control functions of IBM's great new "701" Electronic Data Processing Machines.

These extraordinary machines are providing the nation's defense projects with the most flexible and productive computer ever manufactured in quantity.

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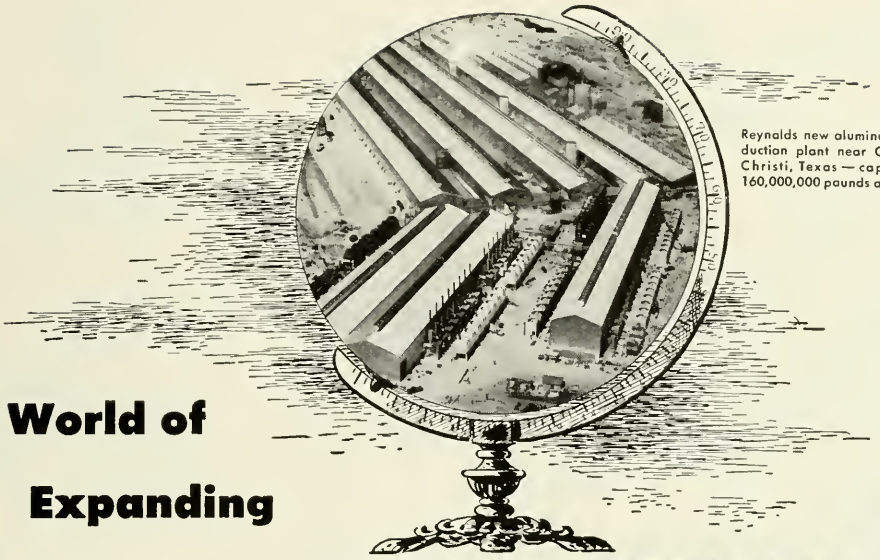

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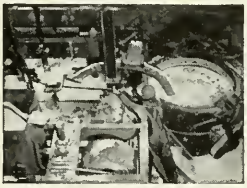
In a land noted for rapid expansion of free industrial enterprise, few companies have matched the swift and continuing growth of the Reynolds Metals Company. Now operating 27 plants in 13 states, and still expanding, Reynolds offers the ambitious engineering graduate a world of opportunity.

Reynolds operations include bauxite mining in domestic and foreign locations...chemical and electrolytic processing to produce aluminum pig ...sheet rolling...drawing and extrusion of mill and structural shapes ...foil rolling and printing...powder and paste production...finished parts and products fabrication. In these and in the allied sales and marketing operations promising careers exist for graduates in virtually any phase of engineering.

On-the-job training is the Reynolds policy—after preliminary orientation which may include basic experience in production plants for sales personnel, and sales office work for technical trainees. Liberal insurance, hospitalization and retirement programs are maintained.

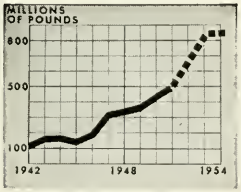
For important background information on "your future in Aluminum," *mail the coupon.* If you are definitely interested now, write direct to General Employment Manager, Reynolds Metals Company, 3rd and Grace Streets, Richmond 19, Va.



Tapping one of huge battery of electrolytic cells

Sheet rolling—reverse hot mill in operation

REYNOLDS ALUMINUM



Reynolds expanding production — historic chapter in 33 years of continuing growth.

Reynolds Metals Company, Employment Dept.
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Please send me, **FREE,** your 96-page booklet, "The ABC's of Aluminum"; also the 44-page book, "Reynolds Aluminum . . . and the Company that makes it."

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Address _____

The Multistage Rocket

by Paul LaViolette, E.E. '55

To attain release from the earth, an object must exceed a velocity of 23,200 feet per second (roughly four times the terminal velocity of a V-2 rocket). The only thing as yet devised capable of increasing acceleration until such speed is reached is the rocket. Following Newton's Third Law, the rocket needs no atmosphere to push upon and is capable of continued acceleration as long as it has fuel. Therefore, to reach the velocity desired, large quantities of fuel must be included in the rocket. It is this mass of the fuel and its container added to the mass of the rocket which has produced the multi-stage rocket. When the propellant in the multi-stage rocket is exhausted from a single stage its container is jettisoned and the next stage fires off accelerating from the velocity point derived from the previous stage.

PAUL LAVIOLETTE is a junior in electrical engineering. His present home is Champaign although he is originally from Kenosha, Wisconsin. Paul is serving as business manager of the Technograph.

To attain escape velocity from the earth, the most practical multi-stage rocket would be the three-stage. Power would be obtained from a liquid fuel such as hydrazine and nitric acid. To have a payload of say 30 tons such a rocket would have a length of 200 feet (about equal to a 15-story building) and a maximum diameter of about 65 feet. Considering the rate of airplane construction today this does not seem overly enormous as to be impractical.

Let us take as an example a rocket that is fired in such a way as to put it 1070 miles above the earth in a satellite orbit. If fired from the earth's equator in the equatorial plane and having the sense of the earth's rotation, then only a slight increase in velocity in the direction of a planetary orbit will cause it to leave the earth's orbit and enter the planet's.

First Rocket Stage

The first rocket stage will be the largest of the three; about 90 feet high and 64 feet indiameter. It will weigh 6400 tons. Large fins for support and guidance through the earth's atmosphere will be included.

Burning time for the first stage will be 84 seconds at which time an altitude of 40 miles will have been reached. At this altitude the rocket will have changed from a vertical ascent angle to an angle of elevation of 20.5°. The velocity reached at this point will be 7150 feet per second.

The first stage will be jettisoned while over water. The use of a water cushion, a streamer parachute, and last minute retarder rockets will make the first and second stages salvageable. The streamers of the parachute must be made of a strong metallic cloth to prevent their being destroyed by air friction. The descent could be tracked by radio impulses sent from the rocket stage and a ship dispatched to recover it. Radio communication to the rocket by directional antenna will be possible throughout the whole trip.

Second Stage

The second stage will be about 45 feet long and tapering from 60 to 30 feet in diameter. Its weight, loaded, will be 600 tons. Burning time will be 24 seconds at which time the rocket will have reached an altitude of 500 miles above the earth, and the ascent angle will have been lowered to 2.5°. It will be landed and rescued in a manner similar to the first stage. As an important economy measure such salvage operations will be essential considering the overall cost of the project.

The cut off velocity of this stage will be 19,260 feet per second. Due to the constant lowering of mass, acceleration per unit of propellant will be constantly increasing.

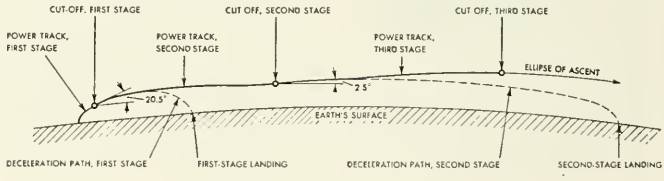
Third Stage

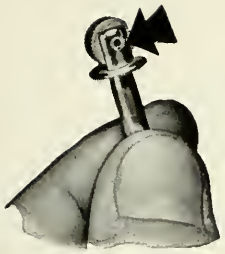
The third stage containing the crew will be the smallest unit of the three; less than 40 feet high and 30 feet in diameter. Firing to reach the desired orbit position should take 73 seconds. However, additional firing may be needed to make a finer adjustment. The ship will now have reached an altitude of 1070 miles and will be just short of escape velocity. The local angle will of course be zero.

At this height the rocket will circle the earth every two hours. Its use in this position would be invaluable even if it never left for outer space. Militarily it would an ideal bombing platform. No nation would want war with the knowledge that such a craft was overhead. Its peacetime uses are important too. Telescopes mounted from such a position would give a viewer a scope of vision impossible on earth, hampered as it is with its dense air mass. Weather conditions such as cloud formations and the like may be kept track of. As a Loran navigational aid it would be indispensible.

Return to Earth

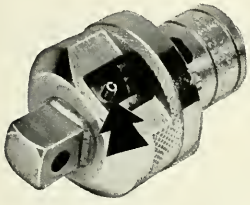
Large wings recessed in the body of the rocket will be used for the return to Earth. A slight downward thrust will be added to reduce the elevation angle below zero. This will be the most dangerous part of the operation, since a miscalculation could result in a velocity so great as to generate enough heat when entering the air mass to disintegrate the ship. Most of the downset will be a long glide. Some of the propellant will have been retained to maneuver for a final landing in a manner similar to any large aircraft. The high landing velocity will necessitate a rather long landing strip, for instance deserted sand flats or a water landing. Vertical landings would be impractical due to the large amount of fuel needed.



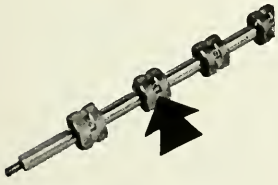


Replacing a rivet

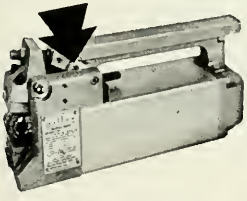
. . . a hinge pin



. . . a stop pin

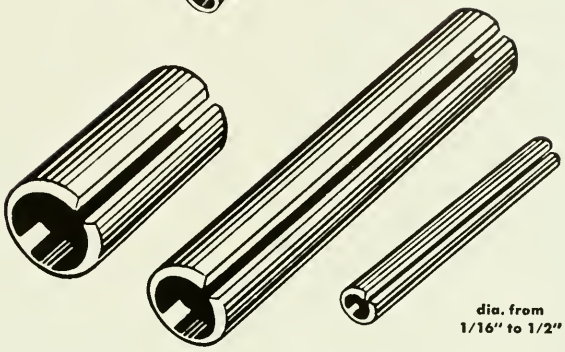


. . . a set screw



. . . a bolt and nut

ROLLPIN



dia. from 1/16" to 1/2"

. . . a modern fastener that saves time and money on thousands of applications

Rollpin is a hollow, split, cylindrically formed pin with chamfered ends. It is simply driven into holes drilled to normal production tolerances. Because Rollpin is slightly larger than standard sized holes, it compresses as inserted. It is self-locking—and vibration-proof—because of the constant pressure it exerts against hole walls. Its shear strength exceeds that of a cold rolled pin of the same diameter. Rollpin is readily removed with a drift or pin punch—and can be reused.

Because of its versatility—and the production economies it makes possible—Rollpin is finding wide usage in almost every phase of manufacturing activity. Write for design information on the Rollpin. It will enable you to cut costs for many applications where use of rivets, set screws, dowels, and straight, serrated or cotter type pins create installation or performance problems.

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey

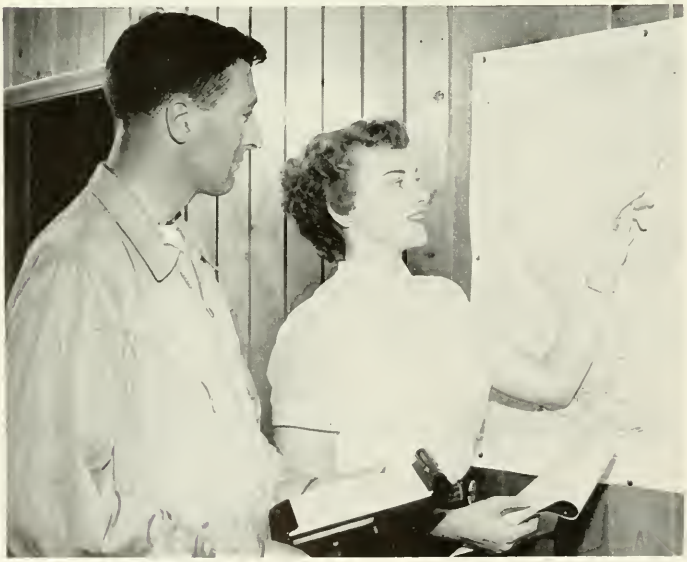
Elastic Stop Nuts with the famous red collar are another ESNA product

ESNA

Patsy Scott is holding an airborne tape recorder which is made by North American Aviation. This photo, in connection with a news release first brought Patsy to the attention of this publication.

Meet Patsy Scott

by Howard Hadler, Ag.E. '55



One of Pat's many duties is checking the flight weather maps and keeping the weather reports and information available for company pilats, such as the pilot shown here checking weather infarmation.

Located at Downey, California, is a huge plant of the North American Aviation Corporation. The plant, engaged in the manufacture of T-28 Air Force and Navy trainers and in long-range guided missiles and atomic energy research, employs several thousand workers. One of these employees is Patsy Scott, a clerk in the Flight Test Group of the plant.

Patsy "Pat" Scott is 22 years old and has been an employee of North American Aviation for approximately 2 1/2 years. She is five feet 7 3/4 inches tall, weighs 128 pounds, has ash blonde hair and a face lightly dusted with freckles.

Pat is of Scotch-Irish descent with about 1/16th part Blackfoot Indian. A native daughter of California, born in Long Beach, she enjoys the outdoor sports—swimming, hiking, golf, badminton. For five years she owned her own horse, an Indian cow pony (strawberry roan), and she still enjoys riding spirited horses. An excellent ballroom dancer, Pat enjoys smooth orchestras, and one of her favorite songs is Hoagy Carmichael's "Stardust."

Pat has been married for almost three years and is an apartment-dweller in the

Patsy receives weather reports coming into the flight dispatching office over the teletype machine.

Patsy is operating the radia transmitter in the dispatching office maintaining contact with company planes in the vicinity.

community of Downey (approximately 60,000 population) about ten minutes' drive from the North American plant. She met her husband, Robert B. Scott, while both were employed at a local phone company. She was a clerk, her husband a telephone-installer. They met when, as she puts it, "He whistled at me once too often, and I stopped to tell him to cut it out."

When she's at home, Pat paints landscapes in oil and water colors, working from memory. A leathercrafter, Pat makes extraordinary wallets and belts. She knits socks, sweaters, and afghans. Another of her home hobbies is playing with her calico cat, Chanel, which retrieves objects like a dog. Pat says that Chanel is better than an alarm clock, waking her up between 5:30 and 6:00 each morning by "biting my nose, pulling out my pin curls, or biting my toes. On weekends we could do without the calico character."

Prior to working at North American Aviation and the telephone company, Pat graduated from the Sawyer Business College in Los Angeles. She is an excellent typist, doing better than 80 words a minute. Her varied duties in the company's Flight Test Group include typing, shorthand, distributing mail, general clerical, keeping records and doing miscellaneous duty in the flight dispatcher's office.

The pilot af one of North American's company planes receives a dispatch from Pat before take-off. (All photos courtesy North American Aviation, Inc.)

Patsy lunches on thhe lawn of North American's Downey plant with her husband, Robert Scott.

out in front...

by design!

A *dynamic industry*, a *progressive company* and a *good start* with basic, broad training are important to a successful engineering career.

With that in mind, consider these facts:

First, the automobile industry continues to expand. In fact, experts predict that 80,000,000 vehicles will be on the road by 1975.

Second, probably no car has ever earned itself a more enviable position in the automobile industry than Pontiac. Pontiac has pioneered many important advances in automobile engineering, advances that have been adopted by the entire industry. But there are many problems still to be solved. Young men with fresh ideas and new approaches—with the guidance of experienced engineers—will solve many of them.

Third, the majority of all leading positions in automobile engineering are held by men who have had experience in designing—one of the most basic approaches to an engineering career.

Yes, there's a great future in store for young engineers with well-rounded training in automobile designing—and this training is especially promising for young men with ability who want a career at Pontiac based on opportunity, advancement and liberal General Motors compensation and employment benefits.

Plan now to design—for a great future!

Pontiac's huge new engineering building is the industry's most modern, with every conceivable facility for designing better and better Pontiacs.

PONTIAC

MOTOR DIVISION • PONTIAC, MICHIGAN

GENERAL MOTORS CORPORATION

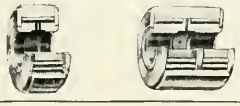
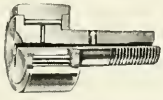
The Torrington Needle Bearing... many types for many needs

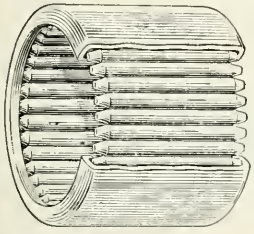
In previous advertisements in this series, the many advantages of the Torrington Needle Bearing and the proper procedure for its installation and maintenance have been discussed. The DC unit type bearing was used in these discussions because it is the Needle Bearing with by far the greatest variety of applications throughout industry.

From the basic Needle Bearing design, however, many modifications have been made. The result is a complete line of Needle Bearings suitable for specific applications. Although these bearings are all different, each offers the advantages which have made the DC unit type so popular. They give the highest possible radial load capacity in a minimum of space; they are light in weight, easy to install and simple to lubricate.

The following chart shows many types of Torrington Needle Bearings, gives their design features and general applications for which they are designed.

The new Torrington Needle Bearing catalog will be sent on request.

TYPE	SERIES	BEARINGS	DESIGN FEATURES	APPLICATIONS
DC	B		Thin, drawn shell, retaining full complement of small diameter rollers. Inner races are furnished when shafts are not hardened.	Wherever high load capacity is needed and space is at a premium.
HEAVY DUTY			The outer race is made in one channel-shaped piece, hardened and ground to precision limits. Heavy inner race.	For heavy-duty applications where split housings occur or where press fit of bearing into housing is not possible.
AIR-CRAFT	NBC		Heavy inner and outer races, with end washers securely fastened to inner race.	Aircraft applications involving oscillating motion only.
	NBE *(left)* NBK *(right)*		Similar to NBC except have self-aligning outer races.	Aircraft applications where alignment is difficult or deflection is severe.
	NBF *(left)* NBL *(right)*		Similar to NBC except have heavy outer races to carry rolling loads.	For use as rollers under heavy loads at low speeds.
CR	CR		Heavy solid-sectioned outer race and rollers made from high-quality bearing steel. Portion of stud which serves as inner race is hardened. Threaded end left soft to avoid brittleness.	Cam follower applications where maximum load capacity and shock resistance are required.



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NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • BALL • NEEDLE ROLLERS

Training Counts...*plenty!*

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MAIL THE COUPON

We'd like to send you a 16-page "get-acquainted" brochure. It tells a lot about Square D, its products, services, markets and opportunities.

Square D Company, Dept. SA
6060 Rivard Street, Detroit 11, Michigan

I'd like a copy of
Square D's "Get-Acquainted" brochure.

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School_____ Class_____

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City_____ Zone____ State____

SQUARE D COMPANY

Ch. E. 372 Exp. No. 6

LITTLE BLUE ROTAMETER

95

F.S.P.

The report you ore about to read is true. Only the data has been changed to give a smoother curve.

Monday, October 5

1:00 P. M.—My name is Chuck Wolfenberger, my partner's name is Ivan Burgener. We were working the day watch out of the Unit Ops Lab. For some time there had been a rotameter, with a suspiciously large dischorge coefficient, lingering in the vicinity of Mezzanine A. Our job—calibrote it.

2:00 P. M.—Mezzanine A. We disassembled and inspected the rotameter (Ser. No. B-25410). In it we found what I hod suspected all along—an orifice. Tracing the air line six feet upstream beyond the Iron Case Meter (No. 1229298) we discovered an on and off safety valve. It looked like an open and shut case.

2:09 P. M.—We reassembled the apparotus.

2:15 P. M.—We began taking data; flow rate, monometer reading, rota meter reading.

2:42 P. M.—Increosed the flowrate steadily to a value of 100 cu. ft. per second. The manometer and rotameter readings remained constant at zero during this time.

6:17 P. M.—Still toking data. We just want the facts. Connected the manometers ond rotameter to the air line. Got much better dota.

6:17 P. M.—Plotted curves from the data of flow rate vs. rotameter reading, flow rate vs. pressure drop, ond pressure drop vs. rotameter reading. They were identicol.

6:17 P. M.—The conclusion was obvious. We had the answer. The pressure drop hod to be constant. What a beautiful curve it made. A straight line. We plotted it over and over. How did we know the pressure drop was constant? We played a hunch, that's all; sometimes a hunch pays off, sometimes it doesn't; we just played a hunch.

6:17 P. M.—My watch hod stopped at 6:17 p. m.

Tuesday, October 6

(wos)

9:00 A.M.—We were all washed up. Our dato were excellent, our curves were in agreement with theory, but we had made one fatol mistake. The jig was up. What wos wrong? We neglected to plot our curves on log-log paper.

On October 9, 1953, triol was held in Superior Court, Room 116 E. Chem. The report was graded and found to be highly improper. The penalty for failing to use log-log paper is a grode of not less than F— or more than E+.

Simple enough now, this vertical ascent was history-making in 1939.

You can remember
THE FIRST SUCCESSFUL HELICOPTER

Just two years *before* Pearl Harbor, Igor Sikorsky took the controls of a weird-looking machine — culmination of a dream of thirty years. Moments later it rose from the ground. Though the flight lasted only a few seconds, the VS-300 became the first practical helicopter in the United States.

Less than six months *after* Pearl Harbor, the Air Force took delivery of the first military Sikorsky.

Since then, rapid developments prove that the helicopter, most versatile of military aircraft, has tremendous commercial potentials.

Helicopters of the future will be the product of tomorrow's engineers. Sikorsky is young and growing. It offers life-time opportunities to young men who choose work where their skills and abilities will be constantly challenged.

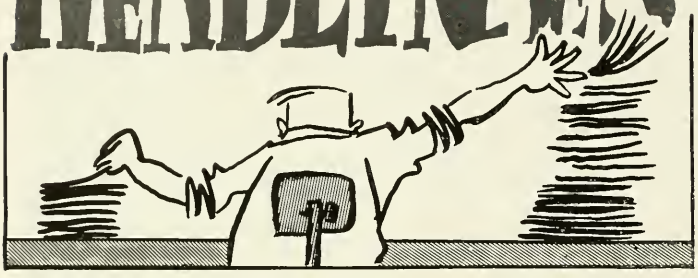
Perhaps *you* belong at Sikorsky — in the research departments, the drafting rooms, the engineering laboratories.

You can *remember* the first successful helicopter — you may be the man to *build* tomorrow's! Learn more about employment opportunities at Sikorsky from C. R. Banks, Personnel Department.

SIKORSKY

One of the four divisions of United Aircraft Corporation **South Avenue** **Bridgeport 1, Conn.**

SKIMMING INDUSTRIAL HEADLINES



by Chuck Foley, M.E. '55, and Martin Goldstein, Chem.E. '55

Techtronic Eye

The Techtronic Eye, causing more excitement in the automotive and safety fields than any new car accessory product, is being readied for national distribution. Technitlex Corporation is now in full-scale production of this new mechanical genius.

Viewed by thousands at the International Motor Sports Accessory Show at the Grand Central Palace, New York City, in March, the Techtronic Eye created quite a stir among car dealers, ultimate consumers, and motor sports writers and enthusiasts.

Designed to reduce accidents caused during night driving trips, the Techtronic Eye relieves the driver of the tedious task of dimming and brightening headlights. It functions whenever, and only when, the car's "open-road lighting" equipment is sent into action. The driver is completely relieved of the task of manually switching light beams. Accidents caused by temporary blindness due to headlight glare become minimized.

In its regular pattern of functioning, an oncoming car moving with its "brights" engaged, would cause the device to undergo a switching action as soon as it appears on the device's "horizon." Your headlights automatically go from bright to dim—stay that way until all oncoming traffic passes. When the opposite lane is clear they automatically return to bright.

The photo-eye component of the device is "targeted" in the direction of oncoming traffic. As the field of this photo-eye component is filled with a given intensity of light, the switching-action takes place. The "field" is a three-dimensional space, of conical-like shape, with its apex at the lens of the phototube component and its principal axis intersecting the line of the oppositely-moving traffic at a distance from the lens corresponding to the "horizon" setting of the device.

For special circumstances, such as signaling, driving in well-lighted shopping centers, etc., the device provides for the hooking into its circuit of the standard lighting equipment floor switch, so that the floor switch may be used in its conventional pattern of operation. You just tap the switch for manual control (as in signaling), tap it again when you want to return to automatic.

Added advantages of the new Techtronic Eye:

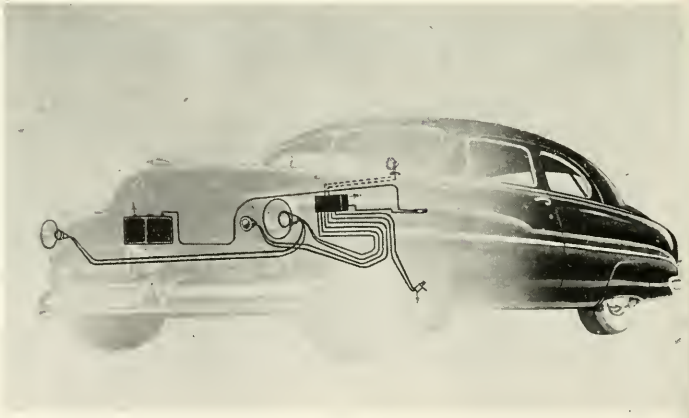
It is ruggedly built to operate on an extremly small amount of electric power.

It obviates the necessity for a sharp voltage regulation system. By running each of the tube stages, inclusive of the cathode tube, at extraordinarily low plate voltages, it provides longer tube life for each tube, thus increasing the life dependability of the device as a whole.

It provides for a bi-directional countermanding system rather than the unidirectional system. It does this while still employing what is even now a standard part of the conventional lighting equipment.

The beam is factory-set, so that the lights dim automatically at a distance approved by all State Motor Vehicle Bureaus.

Techtronic Eye is truly frugal in its consumption of electrical power. It uses less than 1/6th the power ordinarily consumed by your headlights, uses even less than your directional signals, will not affect normal functioning of your battery.



A wiring diagrom showing the wiring layaut on an ordinary outomobile for the techtronic eye to eliminate manual dimming of headlights.

Simplified Control Panel

A little more than a year ago, engineers of Westinghouse Electric brought together on a single plug-in chassis the many d-c control elements located on planes. Now, this standardized panel has been further simplified.

A single-piece base, die-cast of aluminum, takes the place of 50 pieces that previously had to be assembled into one. A frame or support for the several components is molded of high-impact-strength plastic—an innovation in power control devices—and replaces 140 separate pieces.

Junction Transistors

The General Electric Company announced here today it is beginning production of new junction transistors which will provide essentially infinite life for many electronic devices.

Transistors use a crystal of germanium to perform many of the functions of much larger and more complicated electron tubes.

James H. Sweeney, sales manager for germanium products, said the new transistors will greatly extend the lives of automobile and portable radios, and hearing aids. The transistors consume such small amounts of power from the batteries that they too will have greatly extended life.

Sweeney said engineers at Electronics Park are currently engaged in the development of a small transistorized portable radio and are applying the new transistors to circuits under development for radar, airborne computing equipment, carrier current and two-way radio equipment, and television broadcasting equipment.

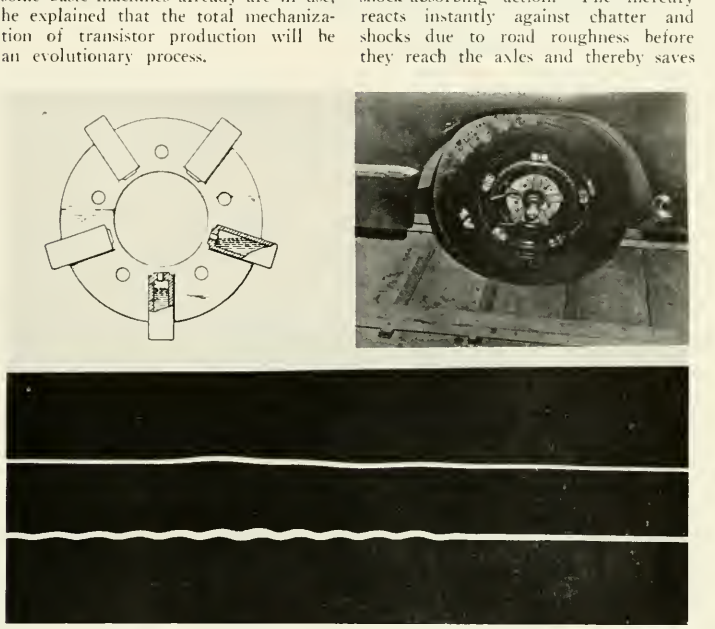
The new transistor was placed on display at the West Coast Electronics Show in San Francisco. In a novel exhibit, the transistor was operated as the heart of a miniature radio transmitter while frozen in a cake of ice, which was then melted and turned into boiling water. Purpose of the all-weather exhibit, according to Sweeney, is to illustrate the transistor's ability to perform efficiently under extreme variations in temperature and humidity.

The new units are evacuated, hermetically-sealed, and of all-welded metal construction. They are the first to feature all-welded metal construction, which eliminates the aging effects of moisture and trapped solder flux fumes.

The G-E official explained that previous methods of construction have failed to produce a transistor whose operating characteristics will not deteriorate with age, as a result of contamination either sealed into, or allowed to enter the casing.

The new construction also allows power ratings up to three times those of any previous transistors, he said. The new transistor has been demonstrated to operate under water at temperatures up to 100 degrees centigrade.

According to Sweeney, the fused junction transistor is a product of many years of research and development. It has been designed to permit automatic mass production, and an automatic factory is now being developed. While some basic machines already are in use, he explained that the total mechanization of transistor production will be an evolutionary process.



A photo and diagram of the dynamic wheel balancer. The graph (bottom) shows difference in vibration brought about by a balancer.

Smoother Rides

A new mercury-reactor attachment for automobile wheels will combine several advantages to give motorists smoother riding comfort. This is accomplished by a set of four discs which can be attached to the wheels of any car. Each disc has a number of radially positioned cylinders containing mercury, and is mounted inside the wheel rim around the axle. The discs are attached to the same lugs which hold the wheels and are covered by the hub caps.

The mercury-loaded discs eliminate the need for balancing weights on car wheels. Weights have never been fully satisfactory because the balance is lost every time a tire is changed or a wheel transposed. Furthermore, uneven wear on tires soon offsets the balance. With the new discs, however, the wheels are constantly dynamically balanced regardless of other factors. This not only produces a smoother ride, but also has proved in tests to extend greatly the life of the tires, because they are made to wear evenly.

The tremendous centrifugal force built up in a rotating car wheel magnifies any unbalance and develops a hammering action. The mercury disc builds up an equal counter force to this and completely cancels the unbalance.

Another important function of the mercury weighted discs is their vertical shock-absorbing action. The mercury reacts instantly against chatter and shocks due to road roughness before they reach the axles and thereby saves considerable wear on chassis points. All other cushioning devices on the car pick up the shock after it has passed the wheel.

The mercury stabilizers also control lateral action. Since the mercury is free to move from side to side, as well as up and down in the chambers, any tendency of the wheels to wobble or shimmy is countered, saving wear on wheel bearings and king pins.

The gyroscopic force built up by the mercury also stabilizes the car's forward line of motion. This helps to straighten wheels out after turns, eliminate drifting, and prevent side-hopping on rough roads.

The discs are the invention of Stuart D. Ormsby, President of Oswego Products Corporation, Oswego, N. Y., who has received clearance on a patent application after two years of product research. His test models are made of aluminum, but he believes that they can be produced in plastic to retail for about fifty dollars per set of four.

Electric Weather Indicator

A swift river of wind in the sky called the jet stream now can be detected in fair weather or foul by a "weather pen" that measures electric charges aloft, the General Electric Company has announced.

According to the company, the jet stream builds a tell-tale positive charge that can be measured by a radioactive antenna installed on the roof of the laboratory at Schenectady, N. Y. A sensitive G-E photo-electric recorder then writes a continuous record of the amount of electric potential in the sky.

The "weather pen," it is hoped, someday may do away with the need for sending expensive balloon-borne equipment aloft to find the location of the heavenly hurricane that often doubles the speed of high-flying planes. It now supplements the use of cloud observation as a means of establishing the presence of the swift corridor of winds, and has led to sharper short-range weather forecasts than could be obtained with conventional weather detection devices.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233)

Of The Illinois Technograph published January, February, March, April, May, October, November, December, at Urbana, Illinois for October 1, 1953.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Illini Publishing Company, Champaign, Illinois;
Editor, Martin Goldstein, Champaign, Illinois.
Business manager, Paul LaViolette, Champaign, Illinois.

2. The owner is: the Illini Publishing Company, a non-profit corporation.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: none.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

Paul LaViolette, Business Manager.

Sworn to and subscribed before me this 19th day of October, 1953.
(SEAL) William George Winn
(My commission expires Sept. 25, 1955.)

Largest Rotating Machine

The largest rotating machine ever built is being put together by the Westinghouse Electric Corporation. It consists of the five compressors and drive for the transonic and supersonic wind tunnels being built for the U. S. Air Force at Tullahome, Tennessee.

Four motors with a combined power of 216,000 horsepower are required to drive the compressors. Statistics on the inlet-stage plades of the transonic compressor suggest the scale of this super wind maker. Each blade is more than two feet across the face, six feet long, weighs almost two-thirds of a ton, and rotates at 600 rpm on a spindle 18 feet in diameter. The top speed for this great mass is 650 miles per hour and the centrifugal force tending to pull each blade from its roots, is 800 tons.

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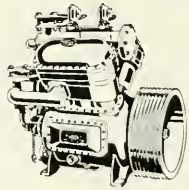

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The most diversified development program in Lockheed's history is under way – and it is still growing. It means more and better career engineering opportunities for you – now and in the future. It means your career can grow with a company that is growing on *all* aviation fronts.

3 *Diversified Living*

You work better in Lockheed's atmosphere of progressive thinking – and you live better in Southern California. You enjoy life to the full in a climate beyond compare, in an area unequalled for opportunities for recreation and outdoor living.

Lockheed AIRCRAFT CORPORATION
Burbank, California

MY SLIDE RULE

This is my slide rule.

There are many like it, but this one is mine.

My slide rule is my friend.

And I shall learn to love it as a friend.

I will obey my slide rule.

When my stick tells me that 5×5 *is 23.9874528349,*

Then five times five is twenty-three point, etc.

I will learn the anatomy of my slide rule.

Though I die in the struggle, I will use faithfully every scale.

The black scale and the red, the inverted C and the inside out legs the reversed A and the multiplied D.

I will master them all, and they will serve me well, they will.

I will cherish my slipstick, and will treat it kindly.

I will call it my baby, and never shall profanity sear its long and graceful limbs.

My slide rule shall be my brother in suffering.

Through long hours of midnight toil we will work together, my slide rule and I.

And great will be the day when my slide rule and I have finished our appointed task, and the problem is done and the answers are right.

I will take that darn stick and have one heck of a fire, I will!

Every year amateur photographers take enough snapshots to encircle the earth three times.

Because silver is a prime ingredient in light-sensitive photo emulsions, Eastman Kodak Company is the second largest individual user of silver in the United States, second only to the U. S. Mint.

To take the biggest flash photo ever made on color film, 2,400 bulbs were exploded at one time in the famous "Big Room" of Carlsbad Caverns in New Mexico.

A chemist employed by Eastman Kodak Company in 1886 was one of the early full-time research scientists in American industry.

The largest color photograph transparencies ever made—18 feet high by 60 feet long—are featured at Eastman Kodak's Colorama exhibit in Grand Central Terminal, New York City.

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HOW TO CREATE SUCCESSFUL DESIGNS

SIMPLY being able to create a unique machine design is no longer enough to insure a successful career in product engineering. Today, more than ever before, a machine design must be strong and durable, *yet be the lowest in cost,* to be acceptable to company management.

As a result, many new designs are of welded steel construction and existing designs are being converted to eliminate excessive material and to reduce the number of shop manhours needed for fabrication.

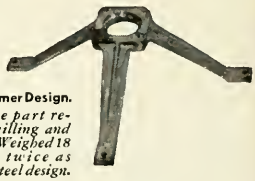

Fig. 1. Former Design. *Machine part required milling and drilling. Weighed 18 pounds, twice as much as steel design.*

Fig. 2. Present Construction. *Bearing Housing and arms are 10 gauge metal. Weighs only 8½ pounds. Cost 30% less to manufacture.*

HOW TO DESIGN FOR WELDED STEEL

As a result of such economies, it is important that forward-thinking engineers maintain close contact with the rapid progress in the arc welding industry. Latest data on design for welded steel construction is available in bulletins and handbooks. Write to The Lincoln Electric Co., Cleveland 17, Ohio.

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ILLINOIS TECHNOGRAPH

ECEMBER 1953

25¢

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It's the piece on the right—one of the U·S·S High Strength Steels—and it has greater strength than the ordinary carbon steel shown on the left. This means that with U·S·S High Strength Steel you can reduce the weight of a railroad car, a truck, a bus, or of many other steel products . . . *without reducing their strength.*

U·S·S High Strength Steel in a $\frac{1}{4}$" thickness can frequently be substituted in a design which uses $\frac{3}{8}$" ordinary carbon steel, without sacrificing strength in the equipment.

Or—you can work it this way. Simply use U·S·S High Strength Steel in the *same* thickness as ordinary carbon steel. Then, equipment will be stronger and more rugged . . . but it will weigh no more!

Furthermore, one of these high strength steels—U·S·S COR-TEN—has high resistance to atmospheric corrosion—4 to 6 times that of plain steel. Think what this means in increased life!

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UNITED STATES STEEL

First things first?

The recent action by the University officials lifting certain restrictions on the use of student automobiles probably was regarded by the uninformed as a symbol of the new Administration's outlook on student affairs. It is certainly indicative. The catch comes in the fact that just so many more vehicles were thrown on the already overcrowded and antiquated streets of Champaign-Urbana.

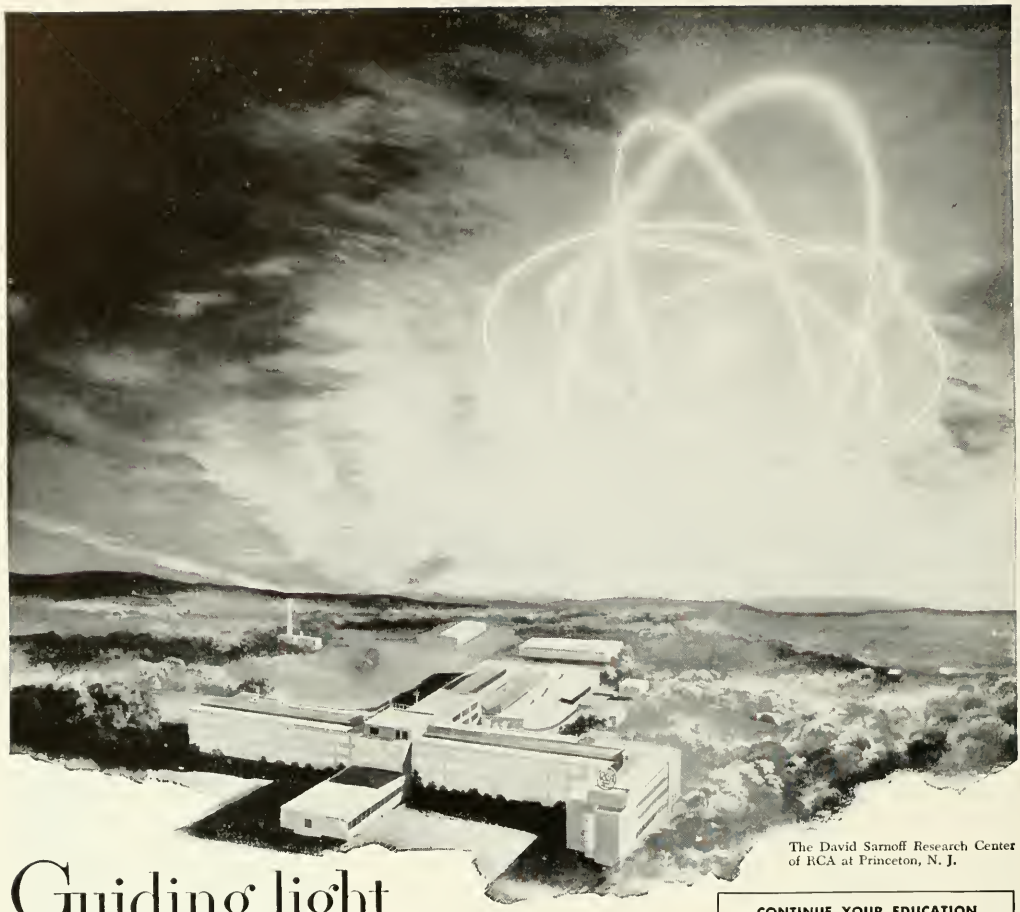
Last semester there was some complaint from students who found it expedient to drive to the campus that the faculty were occupying unrestricted spaces on the streets nearest their offices instead of parking their cars in the faculty restricted lots. This semester there is an indication that even those who are permitted to park in restricted lots find themselves without parking space. And parking is only one phase of the whole traffic picture.

A much more serious situation exists in terms of congestion, vehicle-pedestrian conflict, difficulties in adequate law enforcement and the like. This situation has prompted the reactivation of the faculty Parking and Traffic Committee.

Such committees were active in the past. We have seen recommendations placed before the University administration which would have done much to alleviate many of the problems now plaguing the campus go into files or the wastebasket unheeded. Of course some of these recommendations stepped on a few people's toes, or called for the acquisition of the more useless grass plots for parking areas. Don't get us wrong, we're not in favor of making every grassed area a parking lot, but, we know of quite a few spots that could just as well be parking lots for all the good they serve. The idea is that tradition rules over good engineering and good common sense. Some day tell us how many times the defunct tennis court behind Talbot Laboratory is used. Then tell us how many cars the plot would accommodate.

We wish the new Parking and Traffic Committee well, they have an uphill job, but, their effectiveness is only measured by the extent to which their recommendations are accepted and acted upon.

WHB.



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Published eight times during the year (October, November, December, January, February, March, April and May) by the Illini Publishing Company. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois, under the Act of March 3, 1879. Office 213 Engineering Hall, Urbana, Illinois. Subscriptions $1.50 per year. Single copy 25 cents. Reprint rights reserved by *The Illinois Technograph*. Publisher's Representative—Littell Murray-Barnhill, 605 North Michigan Avenue, Chicago 11, Ill. 101 Park Avenue, New York 17, New York.

THE ILLINOIS TECHNOGRAPH

volume 69 number 3

contents:

editorial ---- 5
time compressor machine ---- 9
on the banks of the boneyard ---- 12
new world's speed record ---- 13
ductile cast iron ---- 17
sports cars ---- 24
introducing ---- 31
project tinkertoy ---- 34
chances are ---- 42
publication engineering ---- 44
savannah river project ---- 51
engineers today, executives tomorrow ---- 55
skimming industrial headlines ---- 60

our cover

Engineering through the years—prehistoric man using brute force to move large objects—next the Egyptians rolling large boulders on rollers—the ancients observing a bird in flight and wishing they could do the same.—James Watt observing the force of steam on a kettle cover—the Bikini atomic test—a hydroelectric power unit—the Wright brothers—Leonardo da Vinci and his sketches of a flying machine—a Viking sounding missile. Today's engineer at his drawing board is looking ahead to bigger things. (Cover by Dave Templeton)

our frontispiece

The frontispiece shows the boom of the dragline used for stripping the overburden from the vein of coal at the Harmattin mine near Danville, Ill. The 180 foot boom has a dumping radius of 174 feet, and it carries a bucket with a capacity of 25 cubic yards. The picture was taken by Assoc. Prof. C. Dale Greffe of the M.E. Department and it has had moderate success as a salon print in National and International Photographic Salons.

TIME COMPRESSOR MACHINE

by Charles Runyan, E.E. '57

Years may now be added to your life by the use of a newly invented "Time Compressor." It is no longer a figment of imagination but a reality. The Time Compressor has been invented here at the University of Illinois, by Prof. Grant Fairbanks, director of the Speech Research Laboratory; Dean William L. Everett of the College of Engineering; and Robert P. Jaeger, electronics technician, formerly at the University and now with a commercial laboratory.

According to Prof. Fairbanks, the machine will actually add effective years to our lives. For example in a normal seventy year span with 15 to 20 per cent compression, five years of effective time would be added to our lives. In the realm of Education during a normal eight semesters work, one semester could be saved.

The Time Compressor was developed from the well known scientific fact that the ear responds quicker than the mouth and can understand a great deal faster than we can speak. Since the human speech organs can't be speeded up without loss of diction and comprehension, a device called the Time Compressor was invented. It simply takes speech or music and compresses it without the loss of a single syllable or note, or without changing the frequency or pitch. In practical effect the machine actually will shorten a 60 minute speech to 50 minutes without detection. Compressions of 10 per cent or even 20 percent pass unnoticed. Even compressions as high as 50 percent does not destroy understanding of speech. Music put through the Time Compressor has its tempo increased, but the pitch and clarity of individual notes are unchanged.

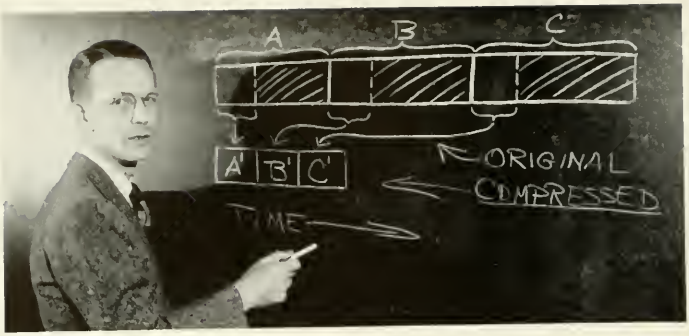
Possible Uses of Time Compressor

Although Prof. Fairbanks was reluctant to predict possible uses of the machine, some that have been submitted are as follows: radio programs "tailored" to fit broadcast time; "talking books" for the blind presenting information understandably at nearly twice the present speed; unbelievable rapidity and precision in music, actually offering new musical experiences; conferences, conversations, airport control direction, etc., recorded on less tape and reviewed in much less time; faster presentation of facts in broadcasts beamed behind the iron curtain, and therefore less danger to listeners; faster reports over long distance telephone or radio; new production opportunities for motion pictures and television; and new techniques for teaching. There are undoubtedly a hundred or more other possible uses for the Time Compressor.

How Time Compressor Works

As has been said before much of what we speak can be classified as redundant and can be eliminated without affecting understanding. This is the principle of the Time compressor. It merely removes

Prof. Grant Fairbanks (left) and Dean W. L. Everitt with the "time compressor" invented at the University of Illinois. (U. of I. Newsphoto)



Prof. Grant Fairbanks demonstrates time compression by the use of phenomes. The "time compressor" was invented at the University of Illinois.

this oral redundancy mechanically. During the experimenting stage, Prof. Fairbanks, after working out the theoretical principles, made a tape recording and cut it into small bits. Each of these bits of tape covered a few hundredths of a second of the recording time. Then he threw away every other one and pasted the remaining ones back together. The result was a little rough but understandable even though half of the sound had been omitted. Then the Time Compressor was devised to discard portions of the incoming sound automatically and to push the retained portions together smoothly without changing the pitch of the resulting signal. This is accomplished without actually cutting the tape. A simple way to look at the machine is this: if you removed every other board from a fence, and pushed the remaining boards close together, you would have a compressed fence. If a sign in large letters had been painted on the fence, you could still read the compressed sign, and it would be in the original color and shape.

The mechanism involves a continuous loop of recording tape on which sound is temporarily stored, and a set of four pickup heads in a revolving drum around which the tape makes a right-angle turn. The pickups are arranged like the spokes of a wheel. Only one touches the tape at a time, and as one moves off another, one comes in contact. As far as the outgoing sound is concerned, the playback is continuous, but actually that part of the original sound which was between the two contacts and untouched by them is left out. In order for this to be accomplished, the tape and drum are run at different speeds and if varied independently any degree of compression can be obtained. If the drum is rotated opposite to that of the tape, each pickup will overlap and the bit of sound there will be repeated and the machine becomes a "time expander."

Theory of Time Compression and Expansion

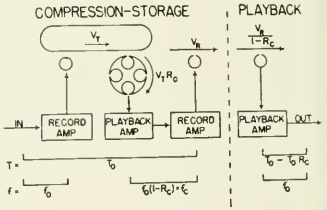
For purposes of explanation assume two different sounds, A and B, of equal duration as shown in Fig. 1. A′ and B′ are the same as sounds A and B, but shorter in duration, but still adequate for perception. A′and B′ are extracted from A and B and abutted in time as shown without discontinuity, and the redundant sound A-A′ and B-B′ are discarded. If the sounds A′ and B′ are reproduced, the time will be shorter than the original A and B but will be just as perceptible.

In the case of expansion, assume that sounds A and B are caused to be repeated, as in the middle portion. If A, A, B, B is reproduced the time will be longer and the auditory effect should be that of prolongation of A and B.

Finally, assume that A and B are first compressed to A′ and B′ and then expanded to A′ A′ B′ B′ as shown at the bottom of Fig. 1. Here the original time for A and B has been restored. A and B have been reconstructed from A′ and B′.

Compression Process

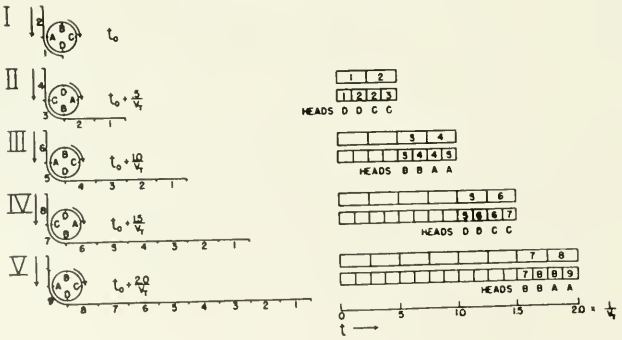
The time compression depends on the revolving head assembly and the four lettered playback heads shown in Fig. 2. The tape passes over the drum and is in contact with 1/4 of its circumference, or a distance equal to the peripheral distance between any two adjacent playback heads. The tape is retained by flanges around the drum periphery. Tape direction is constantly counter-lockwise. In the compression application the direction of drum rotation is also counter-clockwise. Under load the top tape velocity is approximately 190 in. sec. The top peripheral drum velocity is about 225 in./sec.



For purposes of explanation the tape is divided into numbered segments, each equal to the distance between heads. The relative positions of tape and heads are shown at representative times. The diagram shows 50% time compression as an example.

In part I, segment 1 is shown at t_0 when it first comes into contact with the drum. At this time it is intercepted by head A, which is moving in the same direction. If the drum were stationary, reproduction would be one-for-one. If its velocity were equal to the tape, no signal would be reproduced. Between times I and II, however, head A moves through 1/4 of a revolution. During the same interval tape segments 1 and 2 pass through the 9 o'clock point where head A was at t_0. As a result, head A reproduces segment 1 during that interval. The effective tape velocity is V_t-V_h. In the example diagrammed V_h equals

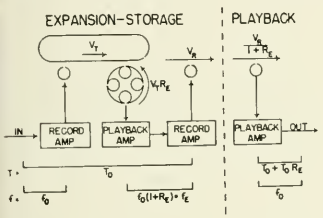
EXPANSION PROCESS



V_1 2 which equals the effective velocity. Therefore, the frequencies of segment 1 as reproduced by head A are divided by 2.

At time II head A is at 6 o'clock and head B is at 9 o'clock, while segment 2 lies between them in contact with the drum. Head A is about to leave the drum, while head B is about to begin reproducing segment 2. Although there is no discontinuity, segment 2 is not reproduced by any head. The remaining diagrams show how the process continues, the odd numbered segments being reproduced at reduced frequency and the even numbered segments being discarded. It is evident that various durations of either reproduced or discarded segments can be realized by varying the absolute and relative velocities of tape and head, and that a range of sampling frequencies and compression ratios can thus be produced.

The output of the device with respect to time is diagramed at the right of Fig. 1. Between times I and II, for example, segment 1 is reproduced by head A in the time necessary for both segments 1 and 2 to pass a point. Head B then

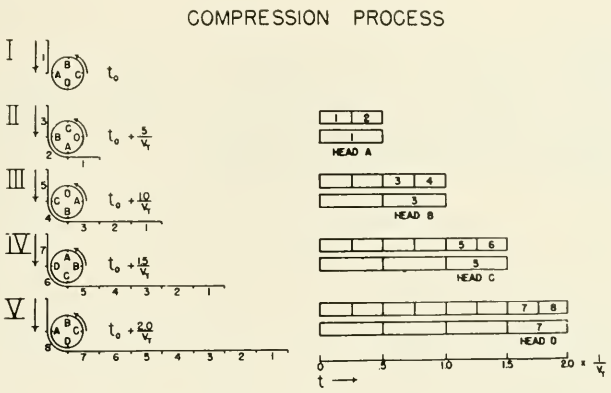


reproduces segment 3, etc. The final yield of segments 1, 3, 5, and 7. When these segments are stored at a given speed and then reproduced at an appropriately higher speed, their original frequencies are restored and the elapsed time is shortened.

With respect to duration the odd-numbered segments are termed sampling intervals; the even numbered segments discard intervals. The reciprocal of their summed durations is the sampling frequency. The discard interval divided by the sum of the two intervals will be termed the compression precentage. Since sampling is periodic the ratio applies also to the total message time, and describes the percentage by which that total time has been reduced. Fig. 4 shows the method of time compression.

Expansion Process

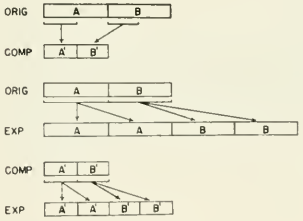
Fig. 3 shows a similar diagram for expansion. Here the drum bearing the playback heads revolves in a direction opposite to that of the tape. The example shows the condition when these velocities are equal. The effective velocity is equal to their sum.



At T_m, shown at I, segment 1 is in contact with the drum between heads A and D. During the next interval head D, as it moves from 6 o'clock to 9 o'clock, will reproduce both segments 1 and 2 and then leave the tape. At that time it will be replaced by head C, which has moved to the 6 o'clock position to intercept the tape at the beginning of segment 2, and which will reproduce segments 2 and 3 during its sweep. The result, shown at the right, is that between times 1 and II, while segments 1 and 2 are passing the 6 o'clock point, segments 1,2,2,3 are reproduced.

Since the effective tape velocity has been increased by the opposite movement of head and tape, frequency multiplication has been incurred. The original frequencies are restored by reproducing the processed message in an appropriately longer time. The amount of time thus added divided by the original time is the expansion percentage. In the diagram this equals 100%. Fig. 5 shows a block diagram of time expansion.

The machine has another important possibility. Instead of compressing time it can be used to compress the tones of a voice, and then to expand them back to original understandability. This is an almost instantaneous process which may



permit a telephone or radio circuit to carry many conversations where one now is carried. This problem of "bandwidth reduction" has interested engineers for a long time. They have found various ways of making circuits do multiple duty, and now the compressor may offer another possibility of carrying more messages without building more expensive transmission facilities.

The University Foundation has applied for a patent on the "time compressor" and will soon grant permission to companies to come to the U. of I and make copies for use in finding out its commercial possibilities.

Husband in movie: Can you see, dear?

Wife: Yes.

Hubby: Is there a draft on you?

Wife: No.

Husband: Is your seat comfortable?

Wife: Yes.

Husband: Let's change seats.

* * *

Mark Twain once debated polygamy with a Mormon. The Mormon claimed polygamy was perfectly moral and defied Mark to cite any passage of Scripture which forbade it.

"Well," said Twain, "how about that passage that tells us no man can serve two masters?"

* * *

The local reporter was interviewing the grandfather of a Hollywood star.

"Does Bill ever come back to the old farm since he's such a big shot in the movies?" he asked.

"Every summer," said the old man proudly, "Every one of the five summers he's been away."

"And did he bring his wife with him?"

"Every time," replied Grandpa, "and they was five as purty girls as you ever laid eyes on."

* * *

Some of the most profitable fiction in the world has been composed by college students writing home for money.

* * *

The best gifts are always tied up with the heartstrings.

ON THE BANKS OF THE BONEYARD

by Alan C. England, E. Physics '54

Future Salaries

In the October issue of the *Iowa Engineer*, Mr. M. M. Boring, manager of the General Electric Company Technical Personell Divisions, gave some facts of interest to future engineers. He states that the average engineer will acquire a position paying $350 per month upon graduation and will be making $830 per month in fifteen to twenty years. Most engineers will not have to worry about being fired in case of a depression. Doctors have the highest salaries in general with engineers and scientists next followed by dentists and lawyers. The bright side of this story is that the doctor has to spend twelve years in school to the engineers four, must make a large investment in equipment, has a shorter life expectance, and a shorter professional life. The need for engineers this year and in future years far exceeds the number graduating. Only about 21,000 will graduate this year while the demand is close to twice that figure.

Engineering Council

At the October 15 meeting of the Engineering Council several positions were filled for major engineering activities in the coming year.

George Hunt was named chairman of the Engineering Open House committee for 1954 and Glenn Zieman was named chairman of St. Pat's Ball. The possibility that the Souder-Finnegan Orchestra might be hired for St. Pat's Ball was suggested.

A booklet on engineering societies and fraternities was viewed by council members for the first time. This booklet was compiled by the Council.

Apologies to J. Kilmer

Recently, in the back of an English Literature book, the following poem was found. It had evidently been written by a frustrated engineer.

Slide rules

I think that I shall never fool,
A gadget handy as a slide rule.
A rule that may be found all year
On the hip of any engineer.
A rule whose indicator is pressed
'Tween the thumbs of one slovenly dressed.
A rule, though used all the day,
That never seems to be in the way.
Poems are made by fools like me,
But slide rules are made only by K and E.

The Boneyard

"By the shores of Alma Mater,
By the shining Boneyard Water,
Stood the wigwam of Illiniwek. . . ."

Our humble apologies to Henry Wadsworth Longfellow for desecrating his work so, but this will serve as an introduction for the freshman to one of the members of the Illini's household of sundry traditions and campus spots—the Boneyard.

The Boneyard, a tributary to a tributary of the Wabash River, achieved its mysterious title when the earliest settlers to Illinois territory came upon it so many years ago. Apparently a group of animals (or maybe despondent students) huddled in a hollow of the bank for shelter (or maybe for a beer party). Anyway, regardless of their origin, they died leaving only a decaying pile of old bones and carrion. The early settlers (incidentally, now history professors) capitalized on the opportunity to name the picturesque creek the "boneyard." Since then it has been nicknamed several times, and one president of the university even tried to have it officially titled "Silver Creek," but through the years just one name has survived the endless cycles of matriculation and graduation at the old State U.

We regret having to construct the epilogue on a sad note, but it is our reluctant duty to report that the romantic Boneyard has degenerated into a melting pot for all the commercial garbage disposal and sewage systems in Champaign-Urbana. Where "Silver Creek" may once have been apropos, "Filthy Firth" is now more suitable. However, once a tradition, always a tradition, and the Boneyard is a permanent fixture in Illini lore.

Chemists Take Note

The following discourse was found last week in one of the dim basement corners of Noyes Lab.

Ten Commandments for Chemists

1) I am the word, thy chemistry text—memorize me.
2) Thou shalt not take the name of thy lab. instructor in vain.
3) Remember the laboratory to keep it spotless.
4) Honor thy lab partner's answers.
5) Thou shalt not spit into thy neighbors unknown.
6) Thou shalt not pencil titrate.
7) Thou shalt not buy thy end product.
8) Thou shalt not bear false answers to thy lab instructor.
9) Thy shalt not covet thy laboratory reagents.
10) Thy shalt not covet thy neighbors beakers, nor his test tubes, nor his Dewar flasks, nor anything that is thy neighbors.

Kind words are short to speak, but their echoes are endless.

* * *

There is no such thing as a big job. Any job, regardless of size, can be broken down into small jobs, which, when done, complete the large job.

* * *

There's a rumor going around that the government is considering issuing this directive: Anything that moves, control it. If you can't control it, tax it. If you can't tax it, give it a billion dollars.

* * *

"How is it, sir, you can make such a substantial reduction in the price of your apples for your friends, and still make such enormous profits on them?"

"Well, you see it's this way. I knock off two dollars a barrel because he's a friend of mine, and then I knock two bushels off the barrel because I'm a friend of his."

* * *

In matters of romance most girls hate a quitter—and also a beginner.

* * *

At most burlesque shows, if the girls' clothes don't drop off, the attendance does.

* * *

All the average man wants in a woman are the bare necessities.

* * *

A gigolo is a man who loves his work and vice versa.

* * *

Or as Mama Gnu said to Papa Gnu: "Bud, I've got gnus for you."

* * *

Steward on an Ocean Liner: "Your lunch will be up in a minute, Mr. Jones."

Seasick passenger: "So will my breakfast."

NEW WORLD'S AIR SPEED RECORD

by Howie Hadler, Ag. E. '55

Only fifty years ago, the Wright brothers completed the first successful flight with an airplane. This achievement in the science of flight seems very small today compared to present standards of flight. This first successful airplane was very crude, and the first flight lasted for only a few short seconds and extended over a very short distance. Today, only fifty years since that first successful flight, air trips of thousands of miles over a period of many hours are everyday occurrences. And the speeds of present day aircraft compared to those of the Wright brothers craft make their efforts seem somewhat insignificant.

On Thursday, October 29, the Air Force reclaimed the world's speed record for its new North American F-100 Super Sabre with one searing pass over the 15 kilometer course of 767 miles per hour and an average speed of 754.98 mph.

Lt. Col. F. K. (Pete) Everet, 33, Chief of the Flight Test Operations Laboratory at the Research and Development Command's Edwards Air Force Base, California, roared across the nearly nine mile course in runs of 767.276 and 732.684 mph. The course extended over California's Salton Sea.

Official National Aeronautic Assn. Timer Bertrand Rhine of Los Angeles, said the mark would be submitted as a new world's speed record. He said under Federation Aeronautique International rules the fastest average speed for either the 15 or 3 kilometer course is recognized as the top official world's mark. The FAI is the international body which regulates all air speed records.

The previous world record was set by a Navy Douglas F4D Skyray over a three kilometer course at a speed of 753.4 miles per hour. Colonel Everest flew nearly 18 miles in setting the new mark over the 15 kilometer course as compared to a total of 7.2 miles flown for the three kilometer record.

The top speed of 707.889 miles per hour for a 15 kilometer course was set September 1 at the National Aircraft Show in Dayton, Ohio, by Air Force Capt. Harold (Tom) Collins in a North American F-86D Sabre Jet.

"This 15 kilometer course is a tough one to fly because at least half of it is over water and it is difficult to pick out landmarks," the veteran test pilot declared. "It's much harder to hold a steady course for such a long distance."

Colonel Everest previously had flown the F-100 over a nearby three kilometer course at an average speed of 757 miles per hour.

Billowing black smoke marked each end of the course and the shoreline at the north end of the site to guide Colonel Everest in his runs. Official timing of the run was with a Speed Graphic Pacemaker camera with Polaroid Land Backs and an electronic counter chronograph.

Air Force Lt. Col. F. K. (Pete) Everest, 33, piloted the F-100 to a new world's record of 754.98 mph. (Photos courtesy North American Aviation, Inc.)

The North American F-100 which hit 767 mph. on one pass and averaged 754.98 over a 15 kilometer course at California's Salton Sea.

Pulling up after his first pass within a few minutes after takeoff from El Centro Naval Air Station, Colonel Everest made a sweeping turn and headed his plane toward the course. "I'm going to kick it in the tail," he radioed. Seconds later the needle nose of the F-100 flashed across the finish line.

Although racing rules permit the 15 kilometer course to be run at any altitude Colonel Everest held the F-100 within 100 feet of the ground on both passes.

The F-100 is the Air Force's first jet fighter capable of breaking through the sound barrier in level flight at altitudes where it will fight.

The Super Sabre is powered by a Pratt and Whitney J-57-7 turbojet engine with afterburner. It is 45 feet long, 14 feet high and has a wing span of 36 feet. Its service ceiling is above 50,000 feet with a combat radius of more than 500 nautical miles.

Colonel Everest is a World War II ace and has more than 4500 hours of flying time, a great portion of it testing and evaluating Air Force planes. He has flown all current production models and research and development aircraft.

Clerk (asking for a raise): I cannot even buy a pair of shoes.

Boss: Then I'll have to let you go. We can't tolerate bare feet around here.

* * *

Judge: One year and fifty dollars fine.

Lawyer: I move to have the sentence reversed.

Judge: Granted. Fifty years and one dollar fine.

* * *

A big shot is a little shot that kept right on shooting.

Two ghosts sat upon an overturned tombstone to talk shop.

"By the way, pal," asked one, "do you believe in human beings."

* * *

Yesterday is a cancelled check; tomorrow is a promissory note; today is the only cash you have. Spend it wisely.

It was a hearing to investigate a case of suicide. When the jury filed back in, the foreman arose and gave the verdict: "The jury is all of the same mind—temporarily insane."

* * *

Visitor: What will you do when you are as big as your Mother?

Little Susy: Diet.

* * *

"Can the baby talk yet, Tom?"

"You betcha. Now we're teaching him to keep quiet."

* * *

Some people think they are big shots just because they explode.

—*Arkansas Baptist*

* * *

The art of acceptance is the art of making someone who has done you a small favor wish that he might have done you a greater one.

* * *

If you keep an open mind, there's a chance that something valuable might drop into it.

* * *

Do the best you can. The forests would be very quiet if all the birds were quiet except the best singers.

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DUCTILE CAST IRON

by Larry Kiefling, M. E. '56

All ferrous metals are composed of one or a combination of several crystal and carbon-alloy forms. Each of these forms has greatly different physical characteristics.

Pig iron as it comes from the blast furnace may contain as much as 4.5% dissolved carbon. The cementite which is formed is very hard and brittle. Much of the carbon must be removed during the manufacture of steel.

The carbon content of gray iron is greatly reduced by the addition of a large amount of steel scrap to the charge. The metal is cooled slowly and

LARRY KIEFLING is a sophomore in Mechanical Engineering. His home town is Cowden, Illinois. Besides being a regular contributor and hard-working member of the Tech staff, Larry boasts a 4.5 average.

the carbon is caused to precipitate as small flakes of graphite. Since the tensile strength of graphite is very low, the metal also has a low tensile strength. The compression strength is almost unaffected. If the metal is rapidly cooled, white cast iron is formed. White cast iron is composed mostly of hard, brittle cementite. Malleable cast iron is produced by annealing white cast iron. It is both slightly malleable and ductile. The change in properties is caused by the very tiny flakes of graphite which are formed.

At an American Foundrymen's Society meeting in May, 1948, the International Nickel Co. announced a new form of cast iron that may revolutionize the ferrous metals industry. This material, called spheroidal cast irron, nodular cast iron, or ductile cast iron, is manufactured by the same process as gray iron, but has a tensile strength almost as great as more expensive steel.

Dutcile cast iron is made by adding a small amount of an alloying element to cause the graphite which is precipitated in the solution to form into tiny spheres. This spheroidal form minimizes the effect of the graphite until it is neglible. Many of the alkali earth metals have been tried as alloying agents, but Magnesium seems to be the best.

Early efforts to produce ductile cast iron by superheating and the addition of a large amount of silicon met with mixed results. E. Piwowarski reports 100% spheroidization with iron superheated in an acid lining and inoculated with .1% ferrisilicon. Superheating alone, in a basic lining did not produce a spheroidal structure, but spheroidization was produced by the addition of .1% ferrisilicon. It was found that traces of impurities such as titanium carbide or aluminum hindered spheroidal crystalization.

German patent 541,296 (Feb. 1928) covers a process for the improvement of cast iron. It specifies that "free and uncombined metallic calcium must be present in the melt, because only this free metallic calcium effects or promotes the graphite formation." Calcium has produced various degrees of spheroidal graphite in laboratory experiments, but the process has never become commercially important. Some success has been attained with the use of cerium as an alloying metal.

The INCO process has been much more successful than any of the others, however. Over 100 companies had been licensed by Sept. 1950. This process uses a 75% Ni-25% Mg alloy to bring about the spheroidization of the graphite. Alloys such as 80% Cu-20% Mg and 25% Ni-50% Mg-25% Si are used to save expensive nickel. Mg-Si alloys have not given uniform results due to the rapid reaction.

Nickel tends to increase ductility and decrease tensile strength. As nickel is by far the most expensive of the alloying elements, efforts are being made to replace it but little success has been encountered.

While less than .75% copper increases strength and hardness more copper will not dissolve and the strength is lowered. Copper causes a marked drop in ductility. Copper is undesirable where high ductility is needed, but is desirable where increased hardness is needed. The effect of copper is minimized by annealing.

A high silicon content is necessary to obtain a complete modification of graphite form. Silicon has a moderate effect when it forms 1.5% go 2.7% of the solution, but brittleness is caused by more than 3.0% silicon. Tensile strength increases 7,000 psi with each per cent increase in silicon content. This gives a distinct advantage over gray iron where a large silicon content causes large graphite flakes. Ferrisilicon is used in the manufacture of both malleable and ductile cast iron to bying about the change change in graphite structure. The usual practice is to inoculate with ferrisilicon immediately preceding pouring.

Ductile cast iron must be relatively free of sulfer. Since much of the manganese used in cast iron is needed to neutralize sulfer, the manganese content in ductile iron can be substantially lower than in other forms. In gray iron with a sulfer content of .1% and a manganese content of .6%, .45% manganese is needed to neutralize sulfer. Manganese is a strategic material which must be imported. Ductile iron may reduce the need for manganese about 7,000,000 pounds per year.

Carbide forming elements such as chromium should be absent to get ductility in the as cast condition. Phosphorus forms its usual brittle phosphide network within the metal. Ductility varies inversely as phosphorous content up to .2%. Phosphorous does not hinder the formation spheroidal graphite. Annealing does not change the effect of phosphorus.

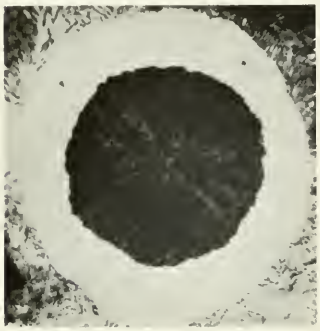
Ductile cast iron has the same process advantages that have made cast iron popular for centuries. The great tensile strength makes economical production of many parts possible for the first time. Production of ductile cast iron is only slightly different than the production of gray iron. The same furnaces and pouring equipment is used although larger gates are sometimes needed. Synthetic green sand is used for molds. Heavier risers are needed on molds because of high coeficient of expansion. The metal has a low melting point, exceptional fluidity, and a high surface tension. These good pouring and molding properties are distinct advantages.

High magnesium loss is a problem that must yet be solved. About 70% of the magnesium added is thrown from the melt as vapor. Ways are being in-

vented to help control this violent reaction. The magnesium yield must be fairly constant in order to get uniform composition with each melt. The composition values need not be so exact if heat treatment is intended.

Production of ductile cast iron in 1949 was 3600 tons. Expected production for 1950 was 15-20,000 tons. Pieces cast ranged from small C clamps weighihng a few ounces to uge hammer anvils weighing 40,000 pounds. Section thicknesses varied from ¼ inch to 36 inches.

Emil J. Loufer of Acme Shear Co., reports that his company is having much



Graphite spheroid in ductile cast iron. (1000x)

success with small castings, even though these must be annealed to get spheroidal graphite. C clamps made by this process could be twisted 90° without breaking. Holes could be punched with no danger of breaking. Annealing ductile cast iron takes only 24 hours while it takes 90 hours to anneal malleable cast iron. No burn-in has been discovered; the sand peels so clean that it is possible to cast sharp edges.

President C. L. Carter of the Albion Malleable Iron Co., is one of the few persons to disagree on the values of ductile cast iron. However, his only trouble is that he has found the cost of annealing high enough to make the manufacture of small pieces uneconomical.

The Chambersburg Foundry Co., has cast some hammer anvils and dies which have been successfully used in industry. Sales for this type of castings is increasing. Cooper-Bessemer Corp., reports successful manufacture of compressor housings which must withstand a pressure of 2,400 psi and of 9 inch deisel engine pistons. Lynchburg Foundry Co., has cast ductile iron pipe which shows many improvements over ordinary cast iron pipe. United Engineering and Foundry Co. reports that ductile iron furnace doors have lasted 17 weeks compared to a 4 week life of gray iron doors. Other foundries report similar success with miscellaneous uses of ductile iron in places where extreme heat and wear resistance was needed.

Fred Freder, foundry superintendent of Valley Iron Works Co., gives the characteristics of ductile cast iron as, "Very close grain structure, develops high finish, welds easily and successfully, high tensile strength, excellent wearability, is free from casting growth problems and its physical qualities can be varied according to the demands of the casting."

The properties of ductile cast iron vary greatly with the type of granular structure. While most work has been done with the ferrite and pearlitic forms, the martensitic and austenitic varieties show promise of many uses. A structure of ferrite is desired to get maximum ductility. To get maximum strength, a pearlite structure is wanted. A martensite form gives the greatest hardness. Ductile cast iron in the as cast state is usually a mixture of pearlite and ferrite. Annealing gives a pure ferrite structure.

Maximum ductility can be obtained by heating to 1600°F, cooling to 1275°F, and holding for 5 hours. A specimen containing .4% manganese and .1% phophorus will have an elongation of 18-23% while a speciman containing .8% manganese and 2% phosphorus will show an elongation of 15% after this heat treatment. Compression strength varies directly with hardness. A test bar with a hardness of 219 Bhn shows a compression strength of 57,000 psi while a bar with a hardness of 321 Bhn will withstand 95,000 psi.

The machinability of ductile iron is very good. The chip produced by ductile iron on the lathe is much longer than that of gray iron, due to the form of the graphite. Annealed ductile iron produces a continuous strip like that of steel. Ductile iron consumes more power

PROPERTIES OF CAST IRON

	Tensile strength	Yield strength	Elongation	Hardness
Gray iron	23,000 psi	———	———	176 Bhn
Malleable iron	44,500 psi	29,500 psi	13.8%	116 Bhn
Ductile iron	99,000 psi	67,000 psi	5.0%	246 Bhn
DI (annealed)	72,000 psi	52,000 psi	17.5%	170 Bhn

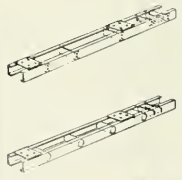
For a successful engineering career, thorough background in welded steel construction is vital since:

GOOD ENGINEERING DESIGNS DEPEND ON COST

With more and more emphasis being placed on cost of manufacture to meet competition, industry's management today looks to its engineers to initiate money-saving ideas in product desigos. As a result, the alert engineering student who can come up with unique money-saving suggestions in his designs will find greater acceptance for his suggestions and a promising future in personal advancement and income.

Often too little attention is devoted to how a product design can be simplified to eliminate costly manufacturing manhours once a basic design is established. To achieve this end, where designers reappraise product details for welded steel construction, production costs are being cut an average of 50% compared with manufacture using castings.

The reasons for the lower cost with welded design are basic . . . lower cost of steel per pound, fewer pounds of steel needed and simpler shop procedures. In addition, steel designs are stronger . . . resist fracture from shock . . . are more modern in appearance.



FORMER BOLTED DESIGN *of base for electric switch. Bases range from 6 to 10 feet long. Are subject to severe cantilever stresses from opening and closing of switch.*

PRESENT WELDED STEEL DESIGN *incorporates tubular cross members. Weight cut 20%. Deflects one fourth as much under load. Costs no more to build.*

DESIGN DATA *for welded steel construction is available to engineering students in the form of Bulletins and Handbooks. Write . . .*

THE LINCOLN ELECTRIC COMPANY
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THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

during machining than gray iron. Ductile iron produces a superior machined surface.

Ductile cast iron can be heat treated to produce superior abrasion resistance. It is possible to produce an object with a hard surface and a ductile, strong interior. The only material comparable to this is steel, cladded with another, more expensive, metal. The possibilities are obvious since ductile iron is much cheaper. Superior plowshears are now being made by this method.

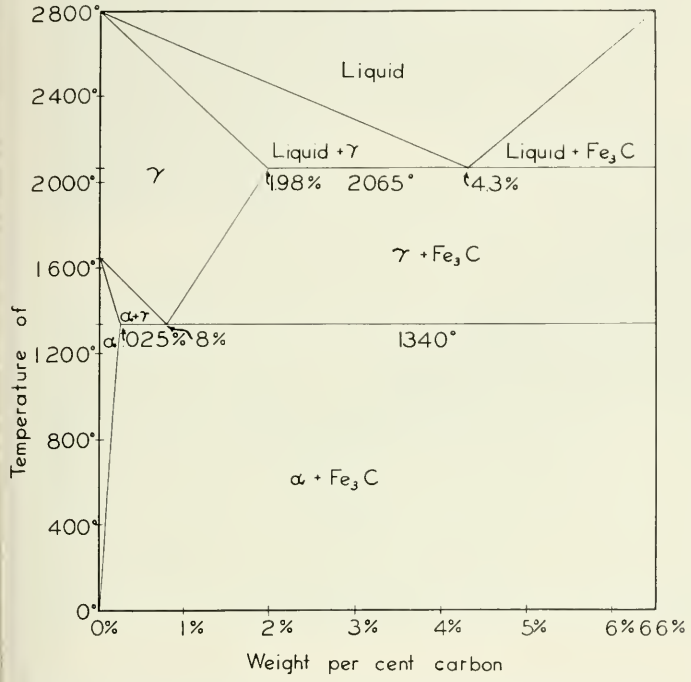
Ductile cast iron is very resistant to extreme heat. On such parts as furnace doors and grates, it far surpasses gray iron. The flake graphite in gray iron causes the trouble by uneven expansion and contraction. Rapid corrosion is the result. In laboratory tests for growth resistance, ductile cast iron was second only to Fe-Ni-Cr alloys.

Tests by INCO show that ductile cast iron wears as well as gray iron, long regarded as one of the best wearing materials. Gray iron is one of the best wearing material in the unlubricated state, because of selflubrication by graphite, but ductile iron equals it.

Lubricated ductile iron bearings last 4 times as long as bronze bearings but cost only 1 3 as much. Ductile iron has good stiffness, torional strength and fatigue resistance.

One of the greatest improvements of ductile cast iron over any other form of cast iron is in weldability. When any ordinary cast iron is heated during welding, white cast iron is formed upon cooling. Ductile cast iron, however can ben easily welded. The spheroidal form of the graphite is not changed in any way. A weld in pipe is stronger than the pipe itself.

Ductile cast iron is replacing cast steel for many uses because of its low cost. Pistons, crankshafts, camshafts, and gears are now being made from ductile cast iron. Ductile iron is used here because of its wear resistance, hear resistance, and its high tensile strength. Ductile cast iron is being used in pumps, compressors, and pipes. Gray iron could never be used for pressure equipment because of the small leaks which develop through the graphite flakes. Cast steel cannot be cast into the complex designs of compressors. Designs which have been on file for years because of production difficulties are being cast in ductile iron. Eight inch ductile iron pipe withstood a pressure of 5,300 psi before it ruptured, but gray iron pipe shattered at 2,400 psi. Ductile cast iron is being widely used in agricultural, mining, and milling machinery.



The alpha form is called ferrite, the gamma form austenite. The compound Fe_3C is called cementite. A eutectic (called lederburite) exists at 4.3% carbon and a eutectic (pearlite) at 0.8% carbon. The region to the left of 1.98% carbon is steel, except the pure alpha ferrite. The region to the right of 1.98% carbon is the cast iron region.

The young bride was asked what she thought of married life.

"Oh, there's not much difference," she replied, "I used to wait up half the night for George to go, and now I wait up half the night for him to come home."

* * *

We are told there is a fundamental difference between what is illegal and what is improper. I do not see this difference, because what is illegal is merely one of the improper things that happens to have been the subject of legislative action.

* * *

About the time you're important enough to take two hours for lunch, the doctor limits you to a glass of milk!

* * *

The lady of the house was showing the new maid about the premises. As they walked into the dining room, she said, "This dining room table goes back to Louis the Fourteenth."

"That's nothin'" interrupted the maid, "my whole living room set goes back to Sears the 15th."

* * *

One thing we like about babies is that they don't go around telling bright things their mothers and fathers have said.

—*Great Bend Tribune*

* * *

There are not many people you can outsmart, but you can outwork quite a few.

* * *

One thing you can never give away is kindness. It always comes back.

* * *

You don't have to stay awake nights to become a success. Just stay awake days.

* * *

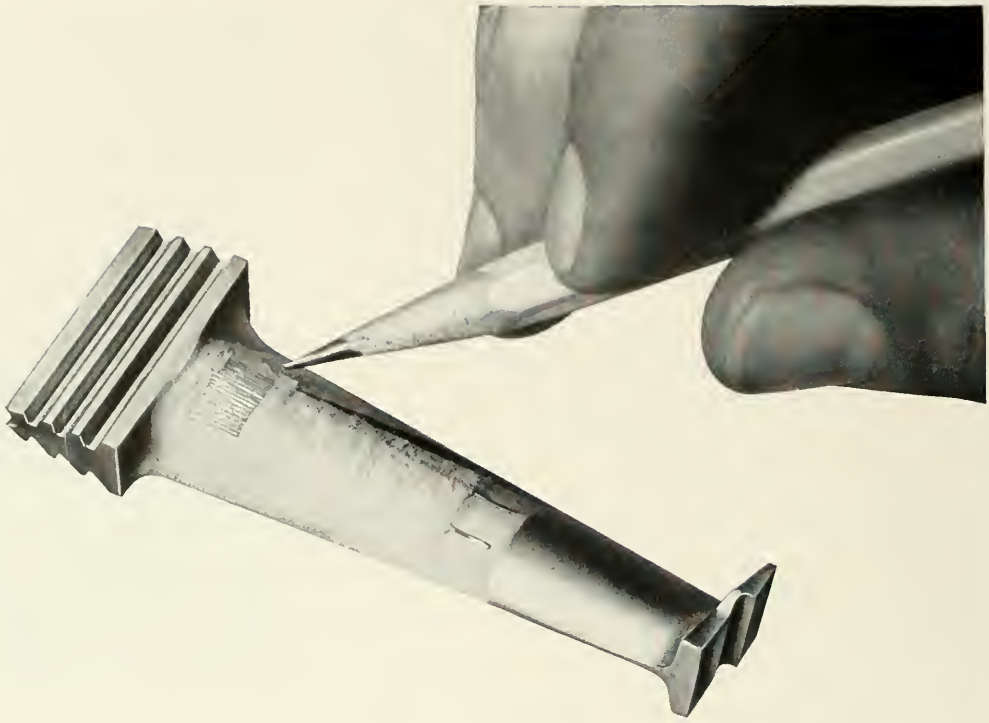
A man should never be ashamed to admit he has been in the wrong, which is but saying in other words that he is wiser today than he was yesterday.

* * *

There is a loftier ambition than merely to stand high in the world. It is to stoop down and lift mankind a little higher.

* * *

If cows knew how much milk was selling for, they wouldn't just be contented—they'd be hilarious.



important wire on a hot subject . . .

Even at temperatures of 1500° — speeds of 12,000 rpm — this tiny wire grid reports to our engineers on the strains in jet turbine blades. It gives them accurate measurements for calculating stresses caused by resonance and flutter.

This basic information, in turn, permits the design of blades that combine the optimum aerodynamic characteristics with structural integrity.

Strain gages are not new. But our engineers had to advance the art considerably to get readings at these high speeds and temperatures. It required the development of improved cements, instrumentation, slip rings . . . new application techniques and calibration curves.

Nothing can be left to chance in the design of aircraft engines for supersonic flight. Thus we use — and frequently improve on — every advanced technique and engineering tool. This straight-forward approach to engineering problems is one of the reasons many outstanding engineering graduates decide on a career at Pratt & Whitney Aircraft.

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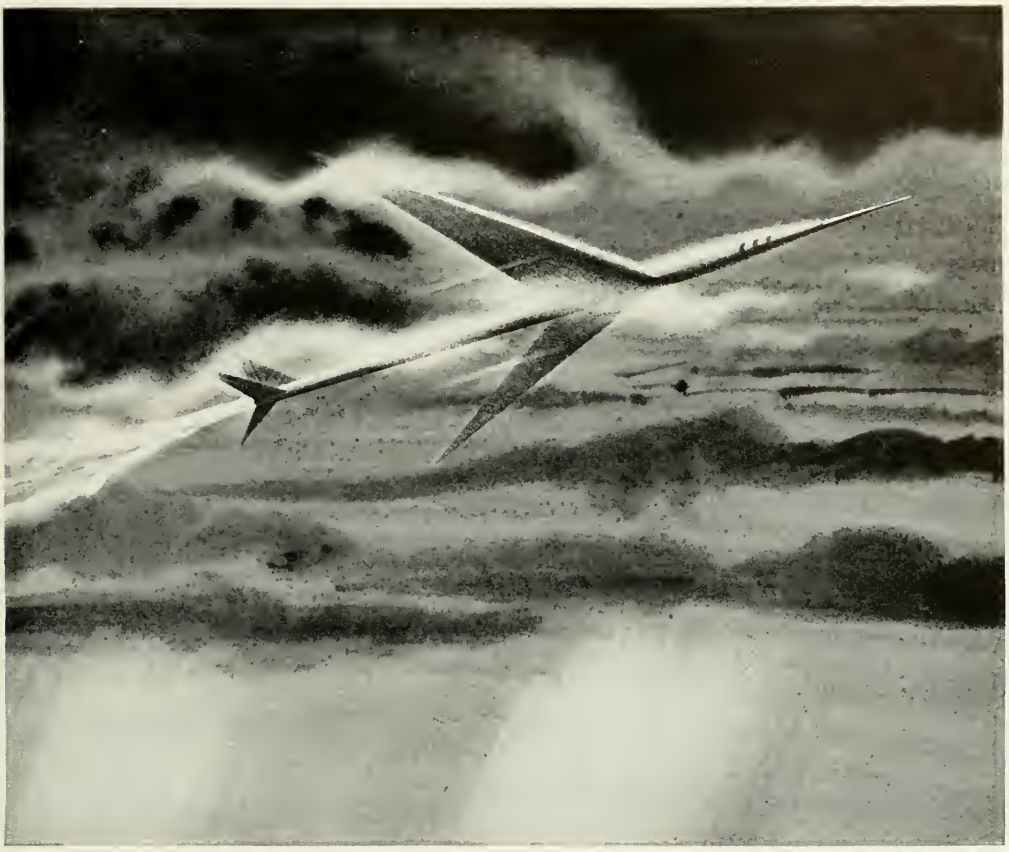

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You'll find Boeing a stable 37-year-old company, that has grown practically continuously. For example, Boeing now employs 6000 engineers in contrast to 3500 at the peak of World War II. And although Boeing is a large concern, it is so organized that each engineer is an individual who stands out—and progresses—in proportion to his ability.

Boeing is constantly alert to new techniques and materials—and approaches them without limitations. Extensive subcontracting and major procurement programs—directed and controlled by engineers—give you a varied experience and broad contacts with a cross section of American industry. No industry, in fact, matches aviation in offering such a wide range of experience, or breadth of application—from pure research to production design, all going on at once.

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BOEING

SPORTS CARS

DON KESLER is a sophomore in Electrical Engineering. Besides his school work and the Technograph, he works on meters in the Instruments Lab. in the E. E. Building. Don is a permanent resident of Urbana

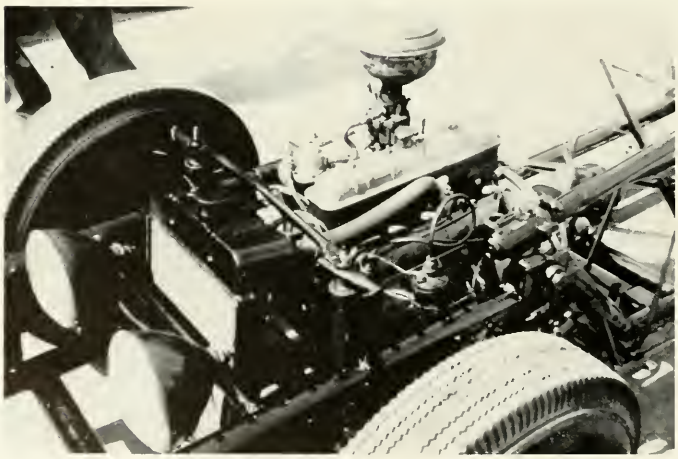
by Don Kesler, E.E. '56

According to the advertisers, Detroit is producing some fine sports cars. This misuse presents a question, what is a sports car? A sport car is a low, small, light-weight car capable of negotiating sharp corners at high speeds. It must have head lights, tail lights, and full road equipment for operating on the highway. It also must have a horn, spare tire, and fenders.If the fenders are the cycle type, they must extend at least an arc of 120 degrees along the wheel and be at least as wide as the tire. Most sports car enthusiasts shun at cars with cycle fenders as being strict racers with covered wheels.

Sports cars must be built to be driven on service station gasoline, since this is what is allowed in sponsored sports car races. The only gasoline that may be used is furnished by the officials, so that rules out all alcohol and nitro mitures. It also keeps sports car racing from getting out of reach of lots of would be enthusiasts. Any carburetor or manifold modifications are legal except in strictly stock classes.

Does your Detroit buggy classify as a sports car? It has headlights, tail lights, a horn, and a spare tire. It has fenders; it will run on regular gas. Oh, yes, it won't turn sharp corners at high speeds.

Turning sharp corners at high speeds is the whole idea of sports cars. The car must have light, quick steering that allows for fast corrections. The suspension must be smooth and firm to give good lateral stability on the turns. Detroit's soft suspension causes body roll in high speed turns, thus the car won't stay under control. Do not put all the blame on the Detroit engineers, though, because it is not their fault that women control America's money.



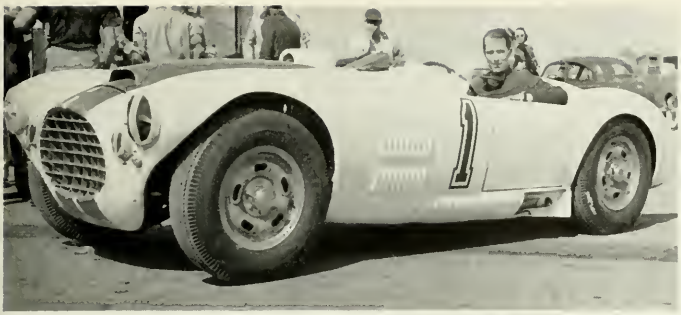
Notice the tubular frame of the Crosley. Norman Goelzer, M.E. '56, built this sports car last summer.

A good sports car must have a low center of gravity and good brakes. By a low center of gravity I mean a few inches above the axle. The lowest center of gravity of any American car is a little less than two feet above the ground. Good brakes will last all day without showing signs of fading. This year's Le Mans twenty four hour road race was won by a Jaguar because it had better brakes than the American built Cunningham. The Jaguar could go farther into a curve before it had to apply its brakes. There was nothing wrong with Cunningham's brakes, only Jaguar's were better. To attain a low center of gravity and finally, high speeds, the car must have a low body line. Wind resistance may not be much in town driving, but it means a lot at 160 miles per hour.

As you can readily see, these cars are safer than most American cars, because they have better brakes and will not roll over. If a sports car is going too fast to turn a corner, it won't roll over; it will skid on all four wheels, if properly driven. Even then the sports car will be going much faster than the American car.

A sports car is balanced. It has 50 percent of its weight on the front and 50 percent on the rear wheels. This gives it better traction than American cars with generally 60 percent of their weight on the front and 40 percent on the rear. Poor balance is what caused power steering to be created. The extra weight on the front wheels caused the car to steer hard. The engineers use either high steering ratios or a power linkage to combat the hard steering. No racing cars have power steering because it takes away the feel of the road.

It's fun to drive a sports car. It's



The C4R Cunnningham and Johnny Fitch have won a lot of races together. This race was at Tampa, Florida. (Photo by Dick Adams, Speed Age)

balanced; it has quick steering; it has plenty of traction. The best of brakes and firm suspension make it a safe car. Where can you find such fine qualities in Detroit cars? Sports cars may not have as much horsepower as American cars, but they don't carry all that excess weight around either.

Being a sports car does not limit a car to any body style. It may be a roadster, hard top, convertible, or a family sedan. Most sports cars are factory built, but a lot of fine ones are built at home.

A highly successful example of the home built sports car is the plastic bodied Crosley. The chassis consists of Crosley suspension attached to a tubular frame. A modified Crosley engine is mounted on the chassis to fit the original drive shaft. The 12 inch Crosley wheels are replaced by 5:00 X 15 inch wheels. Layers of fiber glass cloth are placed in a mold and saturated with polyester resin to form the body. The Fiber Sport Crosley is a nice looking, agile car weighing about a thousand pounds. It is capable of over a hundred miles an hour. The total displacement of this engine is a little larger than an cylinder of a Chrysler or Cadillac V-8. A Hundred miles an hour with that engine is quite an achievement.

July, 1952, was a black month for 60,000 Crosley owners. Crosley had gone out of business. The cause of its failure was the reputation of the copper-brazed Cobra engine. The engine warped, rusted out of shape, and leaked a mixture of oil and water. Over 45,000 cars were originally equipped with this engine, although some of these were replaced with the cast iron block Ciba engine which was standard after 1949. The overhead cam Ciba proved to be a successful racing engine in Crosley's attempt at sports cars—the Hotshot and the Super Sport. What would happen to the poor Crosley owners? Shortly after Crosley's failure, the Crosley Car Owners Club was organized. They set up a parts service and service booklet covering all repairs from the bumpers to the engine. Their organization of 600 members has already saved lots of Crosleys from the junk yard.

Jaguar has come a long way in the mass production of sports cars since 1949. The famous XK 120 Jaguar was born that year. A strictly stock XK 120 roadster, using ordinary gasoline, attained a speed of 132.6 miles per hour in Belgium for the record speed of mass produced automobiles. Later, a hardtop coupe ran continuously for seven days and seven nights at an average speed of over 100 miles per hour.

The competition Jaguar won its first race at Le Mans in June, 1952. The "C Jag" has a 210 horse power version of the dual overhead cam XK 120 engine with a tubular chassis and aluminum body. With a weight of 2200 pounds, the car has almost a horse power for every 10 pounds. In 1952 the Jaguar got too panicked by the Mercedes team and the car overheated early in the race. Le Mans in 1953 went to Jaguar with the aid of a juiced up engine and spot brakes. The new C Jag has about 160 miles an hour top speed. Some of the other cars had a higher top speed than the Jag, but the Jag could go 200 yards farther into a curve before they had to apply the brakes, than their competition.

Mark VII Jaguar is the fastest mass production sedan in the world. The four door aristocratic sedan has been clocked at over 121 miles an hour. The sedan possesses the qualities of a sports car.

Where else can you get such a racing machine as the XK 120 roadster, hardtop coupe, or Mark VII sedan for $4200? The competition model sells for a modest $5,800 in the U. S.

America's only sports car in the present era, grew out a hope of Briggs Cunningham. If the hope of any America can come true, it wouldn't miss Mr. Cunningham by far, since he inherited a major part of Proctor and Gamble and a healthy portion of Standard Oil.

Cadillac heartily assured him that without any hopping up, the 1950 Cadillac would easily win the Le Mans race that year. Lacking the confidence of GM, he bought two of them, souped them up, and accomplished a magnificent feat—tenth and eleventh place among the best European sports cars.

In the following year, 1951, Cunningham converted the Chrysler V-8 to put out 310 HP, mounted it on a tubular chassis and had a body built on the chassis. The cars were complete without any testing just a week before sailing time. Two of his cars spun out and wrecked in the heavy rain early in the race. After running in second place for twenty hours, the third Cunningham overheated due to a misunderstanking on the kind of gasoline that would be used in the race. Despite bad bearings the car managed to cross the finish line in 18th place.

In 1952, value trouble stopped two of his cars, but Briggs drove the third to take fourth place. With equally poor luck in 1953, the three American starters finished third, seventh and tenth. His present car, combined with better brakes, should prove a greater threat in the 1954 contest.

At his West Palm Beach factory, in

The competition Porsche roadster is a soft riding, fast car. Harry Grey drove it at Sebring, Florida. (Photo by Dick Adams)

Another example of opportunities for engineers at LINK-BELT

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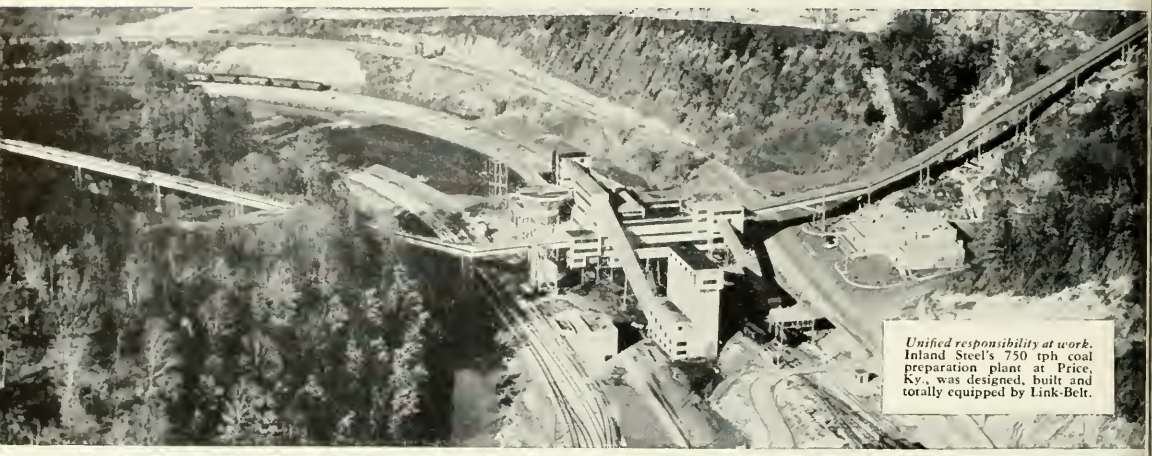

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Minneapolis 5	200 Lyndale Ave., N.
Philadelphia 40	2045 W. Hunting Park Ave.
San Francisco 24	400 Paul Ave.
Seattle 4	3405 Sixth Ave., S.

13.030 A

Florida, Cunningham builds the frames, and mounts the modified Chrysler engines. He ships the chassis to Italy to have a Vignale body fitted on it. You can buy one of America's only sports cars for $10,000 if you have it.

The most popular sports car in America today, is the British imported MG. Plenty of Americans have bought MG's because their Detroit car was beaten by a little car that they could almost put in their trunk. Priced at $2,100 there are over 30,000 MG's in the U. S. today. Until recently, the MG was king of the 1500 cc displacement class. It is still the best buy for a new comer to sports cars. A lot of famous drivers got their start by driving MG's. John Fitch was driving MG's until 1951, when Tom McCahill suggested that he co-drive one of Briggs Cunningham's cars at Le Mans. Since then, he has won more major sports car races than any other driver.

The MG is a sports car in the best tradition. It corners with the greatest of ease and has a four speed gearbox. The engine is small and not powerful, but with this transmission it goes. The little MG, with a top speed of 80 to 85 miles an hour, will beat any American car except the Cunningham on any crooked road. The American car will beat the socks off the MG on the level road, but the MG can make up the time on the corners.

Porsche was the first class F car, 1100 to 1500 cubic centimeters, to soundly beat the MG's. The German Porsche, is a radial design, with a four cylinder opposed engine mounted in the

Jim Kimberly, holding the helmet, is the proud owner of this 2.6 Ferrari. (Photo by Dick Adams)

rear. It has four wheel independent suspension with about nine inches of wheel travel. The employment of the trailing link suspension makes possible the soft ride with horizontal stability. Torsion bars parallel to the axle produce the spring action. The wheels follow the torsion bars like swivel casters without the swivel. The action of the wheel is vertical with a little action forward

John Rutherford drove his XK 120C Jaguar to a record at Daytona Beach. (Photo by Dick Adams)

and backward, due to the arc about the radius of the offset between the torsion bar and the axle. This takes out most of the roll tendencies of the conventional "A" arms that are used on most American cars. It is impossible to imagine such a soft ride, yet such excellent cornering qualities. There is no steering movement over rough roads at the top speed of 110 miles per hour. This aerodynamically styled car sells for $3400 in New York. The roadster and coupe bodies are made of hand hammered steel. The body of the competition model is hand made of aluminum for light weight.

O.S.C.A. is the latest 1500 cc champion. Although OSCA is written and pronounced as a word, the letters are the initials of the Officine Specializzate Costruzione Automobile of Bologna, Italy. The OSCA is built by the famous Maserati brothers. Recently they left the Maserati company, but their high caliber of automobiles is equally evident in the OSCA.

The engine of the OSCA is a four cylinder duel overhead cam. It comes in three sizes—1100 cc, 1342 cc, and 1480 cc. The little OSCA has the 1100 cc engine that puts out 80 horsepower. The next size has the same streamlined body with the enlarged 1342 cc engine and 98 HP. The big OSCA has the 1480 cc engine in a larger body. The price ranges from $7000 for the small OSCA to over $9000. The demand is so great that you have to be content with your name on the waiting list. Although there are less than a dozen in the United States, they have established an amazing record for themselves. The fastest OSCA has a top speed of over 125 miles an hour.

The hottest thing on four wheels, the last few years, is the V-12 Ferrari. The Italian Ferrari is the most consistent winner, and has been unchallenged until the C Jags came along. The reliability of this racing machine is excellent, but the extra equipment, upkeep, and repairs have a habit of being proportional to the initial cost. There are five different V-12 Ferrari engines—1.9 liter, 2.6 liter, 2.9, 4.1 America, and 4.1 Mexico. The bore of the 2.6 engine is only 2.7 inches, and the stroke is 2.23 inches. The *strokes* of all the engines are the same, thus the bore and other modifications are the only changes. The 1.9 liter engine developes 160 horsepower and the car sells for $9,500. The 2.6 has 170 HP; the 2.9 puts out 240 HP. The difference between the 4.1 America and the 4.1 Mexico is 50 horsepower. The 4.1 Mexico is the more powerful with 270 HP and sells for $16,600.

Enzo Ferrari is not the least bit interested in mass production or economy. He wants to build the fastest and best car. These beautiful, complex machines are fast, 170 miles an hour, and at $9,500 and up, they are certainly economical.

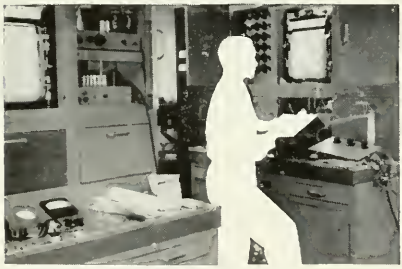
Not all European cars are sports cars. In fact, most of them are built for low initial cost and gasoline economy, thus they are not sports cars. They are no nearer sports cars than most American cars.

Detroit's experimental sports cars are not real sports cars. Using the Cadillac El Dorado for an example, a car with a 126 inch wheelbase, 58 inches high, and 220 inches long cannot be called a sports car. This car is just another of Detroit's monsters. The car weighs enough to make two good sports cars. Good maneuverability comes from a short wheelbase. Most sports cars have a wheelbase of less than 100 inches. A sports car enthusiast will not call a car with a height of 58 inches low. A sports car with automatic transmission and power steering is absurd. Chevrolet Corvette, Packard Caribbean, Buick Skylark—all of them are basically the same car with a different look.

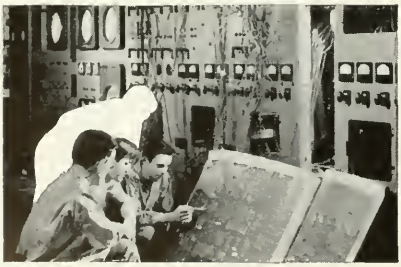
The public wants a real American sports car. Cunningham is producing sports cars, but John Q. wants something to fit his wallet. A $3000 American sports car would break selling records. What is your answer, Detroit?

Sales Engineering

Market Development



Product Engrg. & Research



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A magnetic drum memory unit was chosen as the most compact and rugged storage device for the airborne digital computer. The unit developed by Hughes provides storage space for more than 2500 19-digit words. Density of the magnetic recording is approximately 100 binary digits per inch. Rotating at 8000 rev/min, the 4-inch diameter drum permits computation at a rate of 160,000 binary digits per second.

From an analysis of the logical integration of the memory unit into the computer system, the unique "floating reference" principle was developed. Instead of standard coincidence-type methods for selecting numbers from the magnetic drum storage, a floating reference system is used in which the memory position is determined by counting word times from the *end* of the preceding operation. This technique produces for this application a performance equivalent to a random access memory and results in a substantial saving in equipment.

A major effort at Hughes is also devoted to adapting electronic digital computer techniques to business data processing and related applications — uses unquestionably destined for far-reaching peacetime application.

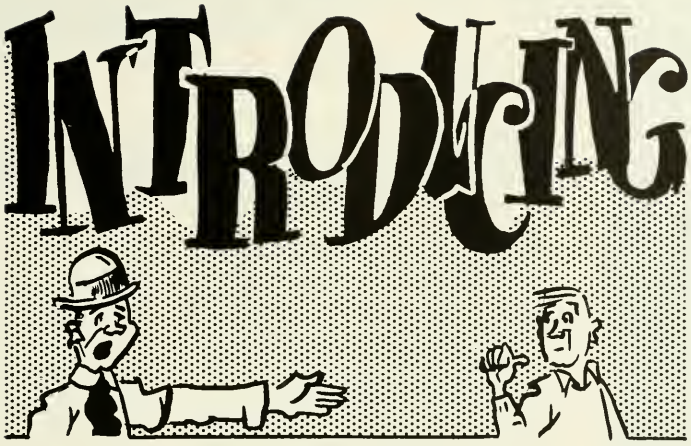
Techniques employed in the magnetic drum memory unit of the Hughes airborne digital computer are reviewed by project members Arthur Zukin (left) of the Radar Laboratory, and Dan L. Curtis of the Advanced Electronics Laboratory.

ADDRESS:
Scientific and Engineering Staff

Hughes
RESEARCH AND DEVELOPMENT LABORATORIES
Culver City
Los Angeles County
California

ENGINEERS AND PHYSICISTS

Activities at Hughes in the computer field are creating some new positions in the Laboratories. Experience in the design and application of electronic digital computers is desirable but not essential. Engineers and physicists with backgrounds of component development or system engineering are invited to apply.



by Charles Runyan, E.E. '57 and
Donna Rudig, E.E. Physics '57

MIKE ZIHAL

The *Illinois Technograph* proudly continues to introduce personalities of the engineering campus. This month we are featuring engineer extraordinary, Mike Zihal, president of the Engineering Council. Mike, a graduate of Brooklyn Technical High School, Brooklyn,

MIKE ZIHAL

New York, was elected to office last spring. While in high school he majored in architecture and was a member of the swimming and football teams. Immediately upon graduation Mike spent 18 months with the 37th Infantry Division in the South Pacific. Mike is also a veteran on the council, having been a member for the past year. He is also president of the Sanitary Engineers.

Last year Mike was a member of the St. Pat's Ball Committee and also won a scholarship in sanitary engineering, which he is majoring in. Besides being president of the Engineering Council, Mike still finds time to belong to the American Society of Civil Engineers.

Mike spends most of his spare time at woodworking, which is his hobby, and at supporting his favorite baseball team, the "Dodgers." During his 26 years, Mike has led a busy life, but somehow managed to find time enough to spend with his best girl, Dorothy, who is now his wife of two years.

Most of his summer vacations were spent working for the War Department in Champaign, but for Mike the part-time work is just about over, for upon graduation in February, he will start work as an engineering superintendent in Freeport, Illinois.

As this soft-spoken, sincere, and outstanding engineer leaves the campus to take his place in society, the members of the *Technograph* give this final salute and a wish for continued success.

PAUL LA VIOLETTE

One of the best known members of the Technograph Staff is Paul LaViolette, our business manager. Now a sophomore in Electrical Engineering, he is following the interest of electricity he acquired while serving in the Navy as firecontrolman. Three of his Navy years were spent overseas, one in Europe and two in Cuba where he picked up his favorite sport, spearfishing, in fact, a Stinger Ray he speared still holds the record for its type in the area.

Paul graduated from Charleston High, Charleston, South Carolina, in 1948 where he was a member of the track and swimming teams. Since entering the University in September 1952, Paul has been carrying extra courses so that he can graduate in August '55. He then hopes to join the Howard Hughes Research Company in Culver City, California.

In July, 1953, when getting his discharge in Virginia, Paul married a rebel beauty. The LaViolettes are expecting a boy (they hope) in February.

PAUL LA VIOLETTE

NO. 4 IN A SERIES

The Importance of

Coverings and Sheaths fo

THE TERM "COVERINGS", as applied to insulated electrical wires and cables, refers to a relatively continuous homogenous layer or layers of impervious and inert material, applied over an insulated conductor or conductor assembly for the purpose of protecting such conductors from moisture, chemical attack and mechanical damage. Coverings may be colored to indicate circuit identification. Chemical attack refers to damage to the insulation resulting from acid, alkalies and other chemicals in the atmosphere or the ducts or soil in which the cables may be installed. Mechanical damage may result from the abraiding, compressing, cutting and tearing forces to which the insulation may be subjected during installation and service.

Coverings may be made of metallic or non-metallic materials. Metallic coverings may be, (1) a continuous metal tube over the insulated conductor, usually made of lead and known as a lead sheath, (2) metal tapes applied spirally about the insulated conductor and referred to as an armor or a shield, depending on the purpose for which it is used, or, (3) metal wires applied spirally either in one direction or in the form of a braid, and again known as an armor or a shield. Armor is a covering applied primarily for mechanical protection or to add strength while a shield is applied to protect the insulation from electrical stresses or for safety purposes. Non-metallic coverings may consist of, (1) a continuous layer of vulcanized rubber or rubber-like material, generally neoprene, or a thermoplastic material, called a jacket, (2) spirally applied, moisture-resistant fibrous yarn, usually cotton or jute, (3) moisture-resistant fibrous tapes, or, (4) moisture-resistant fibrous braids. Combinations of one or more of these may be used as explained later.

The kind and number of coverings used is determined largely by the size of the conductor or cable, the type of insulation on the conductor and the installation conditions. The following is a brief outline of the types of coverings required for the more important types of insulations and installation conditions.

INSTALLATION in DRY CONDUITS and DUCTS

Single-conductor rubber and varnished-cambric insulated cables require a covering over the insulation consisting of a moisture-resistant cotton braid on the small sizes and a double braid or tape and braid on the large sizes for protection against mechanical damage. On 600 volt cables for installation in buildings this covering must be flame-resistant, and is usually colored for circuit identification. A thin layer of neoprene may replace such fibrous coverings on rubber-insulated cables. Paper-insulated cables require a lead sheath for retention of the impregnant and for mechanical protection. Single-conductor polyvinyl chloride insulated cables usually require no coverings since they are generally considered resistant to flame and chemical and mechanical damage.

Multiple-conductor cables which consist of two or more single conductors assembled as a unit are protected by an outer covering. The individual conductors of multiple-conductor rubber insulated cables are generally protected by a single fibrous covering. The outer covering of multiple-conductor cables usually consists of a tape and moisture-resistant cotton braid on rubber and varnished-cambric insulated cables. A neoprene jacket may replace the outer braid on rubber-insulated cables. A polyvinyl chloride jacket is generally used on polyvinyl chloride insulated multiple-conductor cables. Multiple-conductor paper-insulated cables have a lead sheath over the assembled insulated conductors.

INSTALLATION in WET CONDUITS and DUCTS

The coverings described for use in dry locations on both single- and multiple-conductor cables are suitable for use in wet locations except that a lead sheath is required over varnished cambric and non-moisture-resistant rubber and polyvinyl chloride insulations.

Moisture-resistant rubber insulation requires mechanical protection in the form of a fibrous covering or coverings or a neoprene jacket. A neoprene jacket is preferred because of its greater resistance to deterioration in wet locations. Moisture-resistant polyvinyl chloride may be

sulated wires and cables

used without a covering on single-conductor cables.

AERIAL INSTALLATIONS

The types of coverings described for use in wet locations are generally suitable for aerial installations but greater thicknesses of non-metallic coverings, particularly for single-conductor cables, are required. Fibrous coverings for aerial use are usually made of moisture-resistant jute, sisal or loom-woven cotton of large size. Neoprene jackets on single-conductor cables for aerial installations are about 50 per cent greater in thickness than those used for duct installations. These thicker covers provide the additional mechanical protection required for aerial installations. Neoprene jackets are generally preferred over fibrous or rubber jackets because of their greater resistance to weathering. Lead-sheathed cables with the same sheath thickness as used for duct installations are suitable for aerial installations. A lead alloy containing small amounts of antimony or tin is used instead of pure lead to reduce failures due to crystallization.

DIRECT BURIAL

For direct-burial installations, rubber, rubber-like or thermoplastic jackets and lead sheaths are generally used. The jacket or sheath thicknesses are the same as those used for aerial installations. Lead sheaths require protection against mechanical damage. This usually consists of two servings of moisture-resistant jute yarn immediately over the lead followed by two steel tapes over which are applied two servings of moisture-resistant jute.

SUBMARINE and VERTICAL CABLES

Submarine cables require protection against mechanical damage and additional strength over that provided by the conductors to prevent them from being broken by dragging anchors or other objects. Vertical cables frequently require greater strength for their support than that provided by the conductors. This additional strength and mechanical protection is usually provided by a serving of steel wires which completely covers the surface of the cable. This is known as a wire armor. A bedding consisting of two moisture-resistant jute servings is provided between the non-metallic jacket or lead sheath and the armor wires.

PORTABLE INSTALLATIONS

Cables for portable installations such as those used on dredges, shovels and mining equipment must be flexible and their sheaths must be resistant to abrasion, cutting and tearing. Tough wear-and-weather-resistant rubber or rubber-like jackets are therefore used. Such jackets are generally made in two layers with a reinforcing braid of high-strength cotton yarn between them. The jacket thicknesses for such cables are generally greater for a given size of cable than those of cables for non-portable installations.

SHIELDING

Shields consist of one or more conducting layers on insulated electric power cables, the purpose of which is to confine the dielectric field to the insulation on the individual conductors. The two most important functions of shields are, (1) to protect the insulation against harmful electrical stresses and discharges at its surfaces, and, (2) to reduce hazards of shock.

Since harmful electrical stresses can occur at both the internal and external surfaces of an insulation, particularly on stranded conductors, at high voltages, it is necessary to provide shields at both surfaces. Internal shielding in the form of a semi-conducting fibrous material is generally used immediately over the conductor for operating voltages above 2000. External shielding usually consists of a semi-conducting fibrous layer immediately over the insulation over which is applied a layer of metallic material. External shields are generally used at voltages above 3000 for non-metallic jacket cables and above 10,000 for lead-sheathed cables.

Metallic shields are made of non-magnetic materials such as aluminum or copper and are applied as tapes on cables for non-portable installations and as braids for portable cables. External shields must be grounded at all joints and terminals.

For reprints of these pages write to address below.

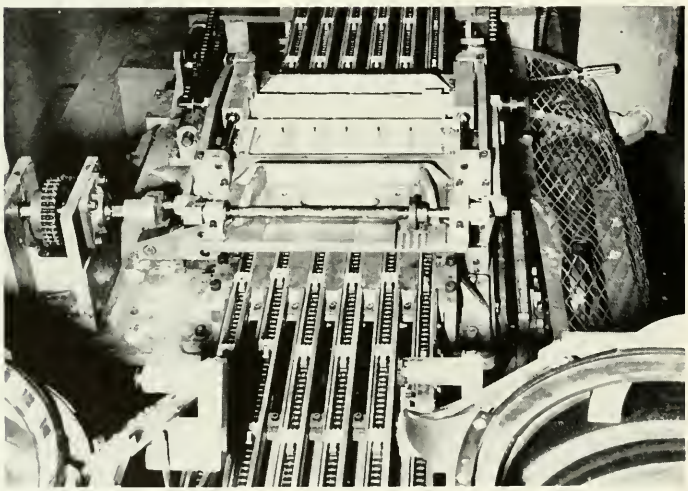
Electrical Wire and Cable Department
Rockefeller Center • New York 20, N. Y.

PROJECT TINKERTOY

(From National Bureau of Standards, U. S. Department of Commerce)

An automatic production line for the manufacture of electronic products and a novel system of electronics design which makes this possible have been developed by the National Bureau of Standards. The program, code-named PROJECT TINKERTOY, was sponsored by the Navy Bureau of Aeronautics.

Starting from raw or semi-processed materials, machines automatically manufacture ceramic materials and adhesive carbon resistors, print conducting circuits and mount resistors, capacitors, and other miniaturized component parts on standard, uniform steatite wafers. The wafers are stacked very much like building blocks to form a module that performs all of the functions of one or more electronic stages. Automatic inspection machines check physical and electrical characteristics of the parts-mounted wafers at numerous stations along the production line. The completed module is a standardized, interchangeable subassembly combining all of the requirements of an electronic circuit with ruggedness, reliability, and extreme compactness.



MPE wafer pottern printer. As wafers are issued from feeder, they are printed simultaneously with the appropriate silver conducting circuit.

Description of Project

PROJECT TINKERTOY was begun by NBS in May 1850 and now successfully produces electronic subassemblies by mechanized means. The pilot plant is operated by a commercial contractor as part of a large-scale production evaluation program under the Bureau's technical direction. The basic objective of the Navy Bureau of Aeronautics in establishing the program was the development of facilities or systems suitable for rapid mobilization in emergency periods. The facilities are also dual-purposed in nature, and are expected to substantially reduce lead time in production.

The key to the automatic, mechanized production of electronic equipment in PROJECT TINKERTOY is the design system developed by the National Bureau of Standards. Called MDS—for Modular Design of Electronics—the system establishes a series of mechanically standardized and uniform modules (or building blocks), producible with a wide range of electrical characteristics.

Each module, in general, consists of some 4 to 2 thin ceramic wafers, bearing various circuits associated with an electronic stage. A number of individual modules are combined to form a major subassembly. The composition of modules into major subassemblies of electronic equipment is possible because there is great similarity between circuits and parts of circuits in modern electronic tubes and arrays of simple parts (like resistors and capacitors), which account for the mass of the individual parts and are also responsible for the bulk of the manual production efforts in conventional production. There assemblies have been the chief target for redesign in the MDE system.

The production of modules and assemblies, designed in accordance with the MDE system, is achieved mechanically in PROJECT TINKERTOY. The production system developed by the National Bureau of Standards is called MPE—Mechanized Production of Electronics. MPE largely utilizes noncritical raw materials. Ceramic wafers —7 8 inch square by 1 16 inch thick—are produced directly in quantity from the raw ingredients. Ceramic capacitors are produced in a similar fashion. Another part of the line produces adhesive tape resistors.

These and other basic parts are fed into the production line. The appropriate circuits are printed by automatic machines. The circuit configuration is achieved through photographic processing. Quality control is established by

automatic inspection, directed by information prepared in punched card form. Special components, not suitable for "printing" techniques, can be incorporated into the modules. Automatic physical and electrical inspection is provided for in the production line.

The MPE system is based on the use of bulk or semiprocessed materials, and the line produces all the large-quantity parts except for the tubes. The pilot plant is designed for a production goal of 1,000 modules per hour. Joining modules together to form subassemblies may also be accomplished by machines.

PROJECT TINKERTOY was sponsored by the Industrial Planning Division of the Navy Bureau of Aeronautics as an industrial preparedness measure. One of the serious bottlenecks in emergency periods has turned out to be the production of electronic equipment, upon which the military services are increasingly dependent for success in modern defense. PROJECT TINKERTOY indicates that lead time in production can be reduced 75 percent.

Modular Design of Electronics

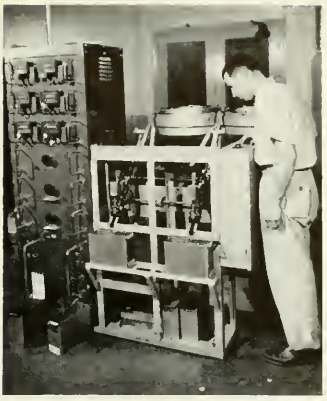
MDE is the basis for the PROJECT TINKERTOY system. In such a system, flexibility of the product and the general characteristics of conventional assembly methods are compatibly combined. At the same time, product standardization and uniformity—the prerequisites for economical processing by automatic machinery—are integral aspects of the system. Interconnection is relatively simple between any number of modular units. By combining modular assemblies containing different component parts (resistors, capacitors, coils, etc.) whole electronic circuits may be developed to amplify signals, generate and shape wave forms, scale count, and perform customary electronic functions. ture of nearly all of these pieces from electronic piece that is to be placed on the wafer. The engineer translates his conventional wiring diagram to an MDE diagram. He indicates the position of the piece and its proper value and tolerances. Lines are drawn to indicate how the circuits between wafers are to be connected.

The engineer's MDE work sheet becomes the basic document from which a draftsman draws an ink drawing that may be reproduced in large numbers. The draftsman also prepares a larger version of the work sheet that is photographed and is subsequently used to make stencils for the circuit printing machines. The numbers of wafers and the tube sockets listed on the MDE work sheets give an indication of the quantity of raw ceramic materials that must be mixed. The number and value of resistors marked on the work sheets determine the production required for tape resistors.

The MDE work sheet is also used to establish the inspection procedure. Current paths on each wafer are marked on specially prepared punch cards. These cards accompany the wafers through all of the manufacturing processes. The sheet is also used in the construction of the standard modules or counterparts that are employed in the final testing and inspection of the module assembly.

Mechanized Production of Electronics

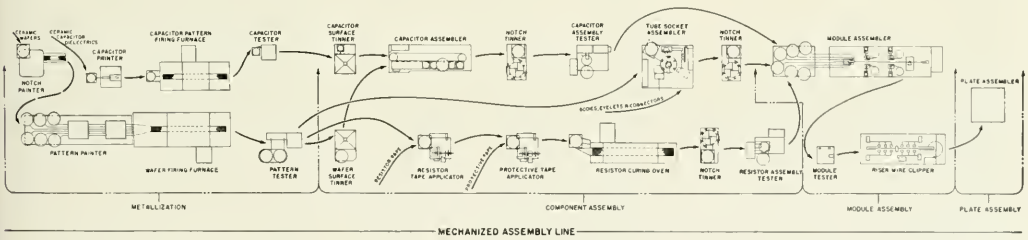
MPE consists of the mechanized production of ceramic wafers, titanate capacitors and tape resistors and their automatic mechanical assembly and inspection. In some military equipment a single chassis may have as many as 100 resistors and 100 capacitors. The facilities of the NBS PROJECT TINKERTOY plant provide for the manufac-



Inspection of pottern-printed wafers.

The standard wafer is pressed with twelve peripheral notches (three on a side) and a keying notch on one side. In the final module assembly, riser wires are mechanically soldered into the twelve notches and serve as physical supports for the module and electrical connectors between wafer-mounted circuits. The keying notch is a medium by which individual wafers are automatically oriented for the mechanical application of component parts.

The titanate capacitor body is manufactured in PROJECT TINKERTOY in very much the same manner as the ceramic wafers. The capacitor is nonporous ceramic composed usually of magnesium, barium, calcium, and strontium titanates of high purity, organic binders and water. After firing, it is about 1 2 inch square and 2 100 inch thick. The capacity values may be varied from 7.0 micromicrofarads to 0.01 microfarad by changing the relative proportions of the constituent minerals. Raw material

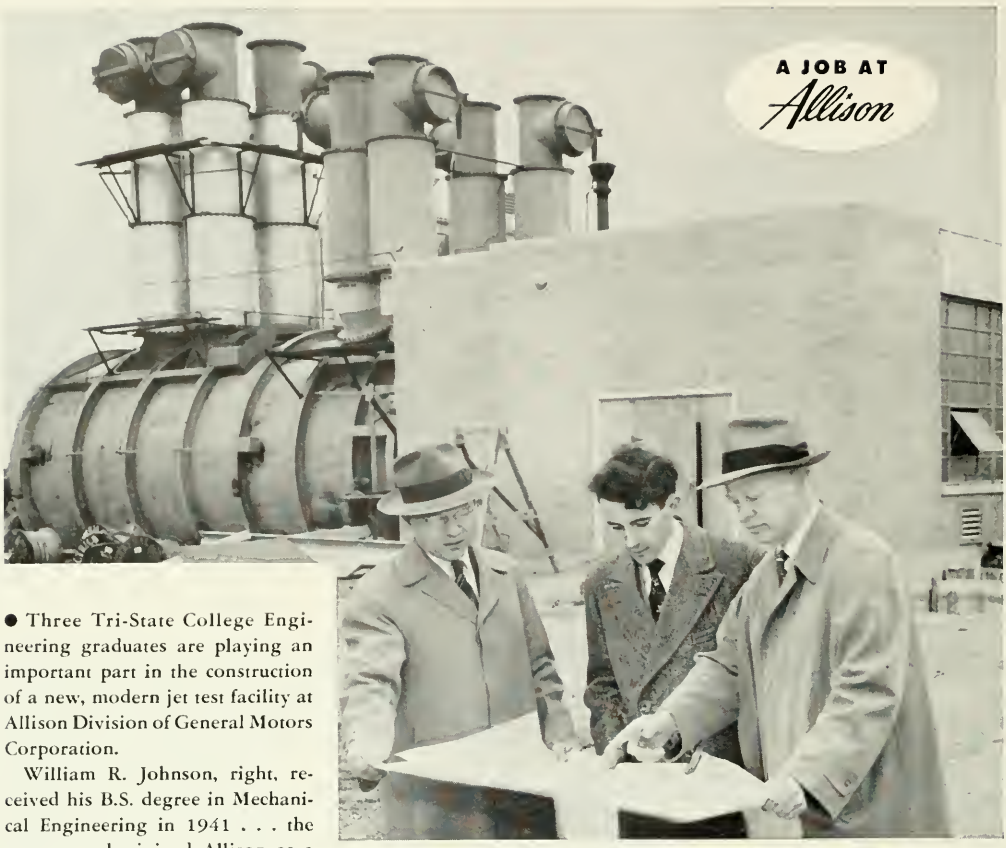


The MDE design system dispenses with the conventional circuit diagram of the tested electronic model and places all necessary production programming information on an MDE work sheet. Each work sheet contains the front and back outlines of six wafers with appropriate numbering to identify each notch in the wafer, each riser wire, and the raw materials.

Steatite wafers and tube sockets are processed from raw materials and are stamped out at a rate of about 2800 pieces per hour. These parts are cured at 2300°F in a tunnel kiln. The wafers are then mechanically gaged, and all pieces which do not fit within close tolerances are rejected.

batches weighing about five pounds will produce about 100,000 capacitors.

The materials required for the manufacture of tape resistors in PROJECT TINKERTOY are a heat-resistant asbestos paper tape known as Quinterra, polyethylene tape, carbon black or graphite, resin, and a solvent. The resistor formulation (a mixture of the carbon,



● Three Tri-State College Engineering graduates are playing an important part in the construction of a new, modern jet test facility at Allison Division of General Motors Corporation.

William R. Johnson, right, received his B.S. degree in Mechanical Engineering in 1941 . . . the same year he joined Allison as a junior test engineer. In 1952, after several promotions and a period in military Service, he became an engineering supervisor and was assigned the responsibility of engineering the eight jet engine test cells at the new experimental plant. The new test cells—revolutionary in design—make use of huge 100-ton steel tanks calculated to withstand an ultimate internal pressure of 175 PSIG.

H. F. Prang, left, was graduated in '42 with a B.S. in Mechanical Engineering. Later, he joined Allison as a draftsman in connection with the development of sleeve type bearings for aircraft engines. From the beginning of the new test plant program, he has been supervisor of drafting in the "Experimental Jet Facilities Group" which provides all designs of test equipment in the building.

Edward G. Delaney, center, received his B.S. in Mechanical Engineering in 1951. He was recently promoted to the "Test Projects Control Group" at Allison. His job will be to use the new equipment and facilities in the testing of jet engines. He will be running individual tests on components, and coordinating proper control installations on experimental engines.

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resin, and solvent) is ground to a fine adhesive powder. The compound is then sprayed on a loop of Quinterra tape, and a protective coating of polyethylene tape is applied. The tape is slit into five or six narrow strips and stored on rolls in a refrigerator. A 75-foot roll of tape will produce over 10,000 resistors. The tape resistors produced have a range from 10 ohms to 10 megohms. They will hold their rated resistance within ±10 percent up to temperatures near 200°F and are capable of 1/4-watt power dissipation at the operating temperature.

Metallizing is the name given to a series of operations in the PROJECT TINKERTOY plant in which appropriate sections of the wafer or capacitor body are silver painted. During these stages, circuits are printed on the wafers, notches are coated, conducting surfaces and leads are applied to capacitors, furnace-curing takes place, and circuits are inspected. Finally, all silvered surfaces received a thin coating of solder. All of the operations are mechanized.

The keying notch pressed into each wafer is initially used during the metallizing operations. The wafers are loaded into vibratory bowl feeders provided with spiral escape channels. A series of four exit ports followed by steps are set into the channels. A small screw is inserted into each exit port that permits only those wafers to pass if the key is aligned with the screw. If the wafer is incorrectly oriented, it is turned 90 degrees as it falls down the channel step following the exit port. A specially grooved channel inverts the wafer if it has failed to pass through the other four ports, and the keying procedure is repeated. As a consequence, all wafers passing from the feeders are oriented in the same direction and have the same surface turned upward.

Another feature of the vibratory bowl feeders is the mechanism that controls the quantity of wafers being issued. The issuing channel is provided with a photoelectric cell that functions only if the light path is completed. If the channel is not filled with wafers, the completed photocell light path energizes the circuit causing the bowl to vibrate. When the channel is full, the bowl automatically stops vibrating, and, therefore, issuing wafers.

Tape resistors, titanate capacitors, tube sockets ,and other miniaturized parts are mounted on the wafers between the appropriate silvered conducting patterns. Rolls of resistor tape are placed on a machine that automatically cuts the tape into one-half inch lengths, presses the resistors between printed electrodes on the surface of the wafer, applies pressure, and ejects the completed resistor-mounted wafer. As many as two resistor tapes may be applied to each wafer surface.

A single machine is used to mount up to two capacitors on each surface of a wafer. Each capacitor is automatically oriented and the silvered circuit on both surfaces is electrically tested before mounting. For example, if four capacitors are to be mounted on a wafer, the first two are dropped into a conveyor driven jig. They are followed by a slave that centers the capacitors, and the properly oriented wafer is added. The remaining two capacitors are dropped on top of the wafer. The jig is conveyed through a pair of induction heaters that cause the tinned surfaces on the parts to bond.

In the tube socket assembler, silvered tube pins are mechanically placed into their proper holes in the steatite tube socket, a wafer is placed on top of the socket, and a rivet binds the two pieces together.

After the various parts have been mounted on the wafers, the notches on wafer are tinned with solder. The machine that performs this operation automatically grips each component-mounted wafer and dips one side into flux and solder. The tinning operation is repeated on the other three sides after successive 90 degree-turns of the wafer.

Uniform wafer-mounted component parts, including wafer-mounted coils, toroids, potentiometers, and crystals are now ready for assembly. The complete assembly of the module is accomplished in a single machine. Six vibratory feeders issue the wafers to a loading device that holds the wafers in an upright position between specially designed jaws. A chain drive carries the jig to a soldering position at which six riser wires are guided into appropriate notches, three on a side. Th emechanism brings soldering irons in contact with the unit and bonds the wires to the notches. The unit is turned 90 degrees, and the chain drive carries it to another soldering position where six more wires are bonded to the module. After final electrical inspection, segments of riser wires are severed where circuit isolation is required between wafer-mounted circuits.

During each stage in the mechanized production of electronics, provision is made for 100-percent automatic inspection. This is both a physical gaging and an electrical comparison. Printed circuits, resistors, and capacitors are compared with their electronic equivalents both before and after assembly. This is accomplished by use of electronic computers, bridge circuits, and other comparison devices. The inspection "code" is contained on the punched cards which were prepared by the design engineer and have accompanied the wafers all through the production process. After the final assembly of the module the whole circuit is again tested to see that it meets specifications within set tolerances.

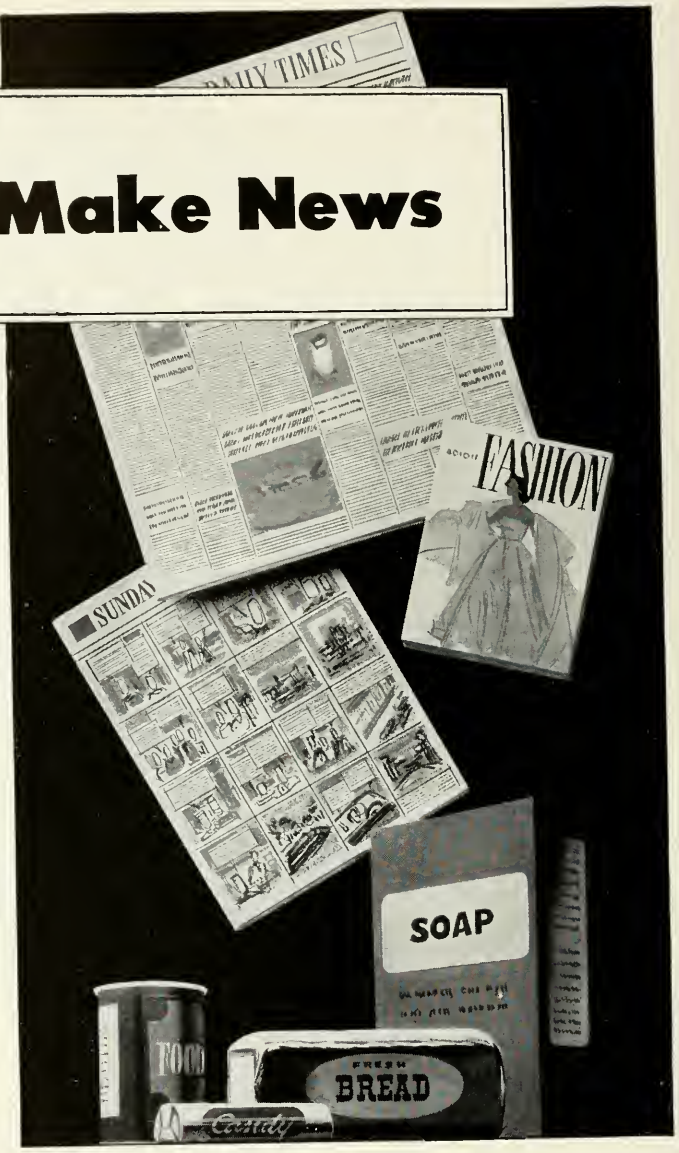
The final assembly operation need not necessarily be considered a part of the Mechanized Production of Electronics. Normally, a set of modules (as many as ten) are mounted on or between copper-clad base plates. Circuits have been etched into the copper surface and connect the riser wires of the several modules to form a complete electronic circuit. Several such plate assemblies may form an equipment. One base plate with six modules, for instance, contains all the necessary circuits to make a six-tube radio receiver function properly.

Inter of the PROJECT TINKERTOY pilot plant, conceived ond developed by the National Bureau of Standards.

Industrial Preparedness

Industrial mobilization and preparedness have been studied by the Industrial Planning Division of the Navy Bureau of Aeronautics for many years. In study-

Resins Make News



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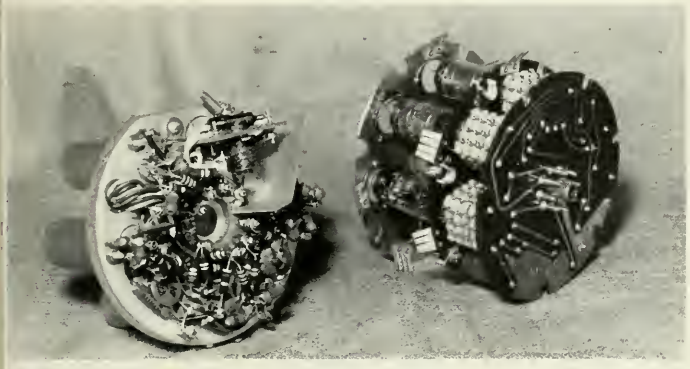
ing the electronic industry it was concluded that in the event of a national emergency costs for production and maintenance of electronics would be formidable in view of the quantities and varieties of needed gear. Consequently the Navy Burea uof Aeronautics decided that the only solution to the problems of satisfying the huge demands for electronic equipment was a mechanized production system.

The Navy turned to the National Bureau of Standards in 1950 for the solution of these industrial mobilization problems. The National Bureau of Standards had engaged in pioneering work in printed electronic circuits, stemming from problems arising in its proximity fuze work during World War II. Prior to 1950, the Bureau had developed a modular design concept, tape resistors, special circuit printing techniques, and hand-machines for printed circuits in connection with various research and development projects. Problems of miniaturization and ruggedization of electronic equipment had also been under study for some time.



Electronic equipment produced by conventional methods (left) and an MPE version of the same piece of equipment.

The first modular design of military electronic equipment had been completed by NBS in 1949, when a radar intermediate frequency assembly had been designed and constructed. A careful study by the Navy in 1950 indicated that "the most advanced state of processed circuitry is available at the National Bureau of Standards." The NBS system was particularly compatible with military environmental requirements, and constructed by the Navy in 1950 indicated that "the most advanced state of processed circuitry is available at the National Burau of Standards." The NBS system was particularly compatible with military environmental requirements, and stressed maximum use of raw materials rather than pre-processed component parts. The major objective of the program became the design and construction of a pilot plant compatible with the principles of Modular Design of Electronics.

PROJECT TINKERTOY makes possible a rapid conversion from civilian to military products (and back again) on short notice and, concurrently, allows a greatly expanded production capacity. Delays caused by the need for recruiting and training new production personnel and the procurement of new mechanisms and parts are eliminated. Most of the operating "know-how" is stored in mechanical fingers and electromechanical control mechanisms, and even electronic equipment designs may be stored, ready for production, in the form of punched cards and circuit stencil screens.

Because PROJECT TINKERTOY largely utilizes unprocessed or bulk materials, the system is comparatively free from dependence on particular components in critical supply. The Mechanized Production of Electronics results in a very high production rate. Uniformity of electronic products at a high quality level is enhanced by the mechanized production and by 100% automatic inspection. This affords the possibility of repair and maintenance of electronic systems by replacement of untized packages or entire subassemblies.

Performance of equipments produced in PROJECT TINKERTOY appears generally equivalent to that obtainable from conventional assemblies. Equipments produced on an experimental basis meet military environmental requirements, passing such tests as shock, vibration, temperature, and humidity established in military specifications. Moreover, the standardization and uniformity achieved by the MDE wafer-component and stacked-wafer design result in production outputs of uniformally satisfactory equipment, whose characteristics both physically and electrically are carefully controlled through the 100%-automatic inspection machines that are an integral part of the production line.

The final design and subsequent construction of many PROJECT TINKERTOY machines called for the services and assistance of industry at a time when the Korean emergency had preempted most machine-tool and related facilities. The Navy and the National Bureau of Standards were able, however, to secure the cooperation of several companies with available facilities and staff.

Basic conception and development—as well as early background research—were contributed by the National Bureau of Standards, including solution of new process and materials handling problems, design of the pilot plant and much of its equipment, and technical direction of all phases of the program. While some of the plant machines were designed and constructed by NBS, the major part of the design and construction of the production equipment was done by the Kaiser Electronics Division of Willys Motor Co. Some special machines were also designed and built by the Doughnut Corp. of America (Ellicott City, Md.). Specially designed automatic production test equipment was obtained principally from Communication Measurements Laboratory, Inc. (Plainfield, N. J.). Some major engineering applications to equipment were made by Sanders Associates, Inc. (Nashua, N. H.), including environmental studies of MDE units. The Davies Laboratories (Riverdale, Md.) and the Navy Post Graduate School (Monterey, Calif) also rendered assistance in some phases of the work. Acknowledgment is also due to many companies and individuals who contributed auxiliary services and supplies.

"I see you're driving a new car."

"Yes, I tried to sell an insurance policy to an automobile salesman."

* * *

An old-timer is a fellow who remembers when he could buy a pound of steak for a dime, but forgets he had to work an hour to earn the dime.

* * *

A smart girl is one who quits playing ball after one good catch.

* * *

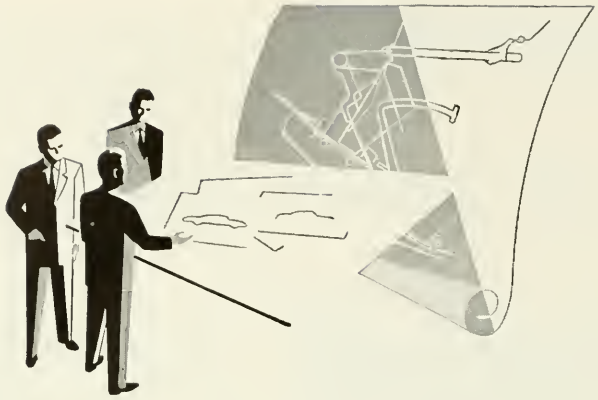
Women's tears: the first successful Fluid Drive.

* * *

Arguing with a woman is like trying to read a newspaper in a high wind.

* * *

If most women had it to do over, they'd marry the man they didn't have to do over.



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There's a great future for young men with well-rounded training in the dynamic and expanding automobile industry, and nowhere is there greater promise for continued growth than at Pontiac. Experienced engineers are anxious to work with young men to design the finer car that will insure this continual progress.

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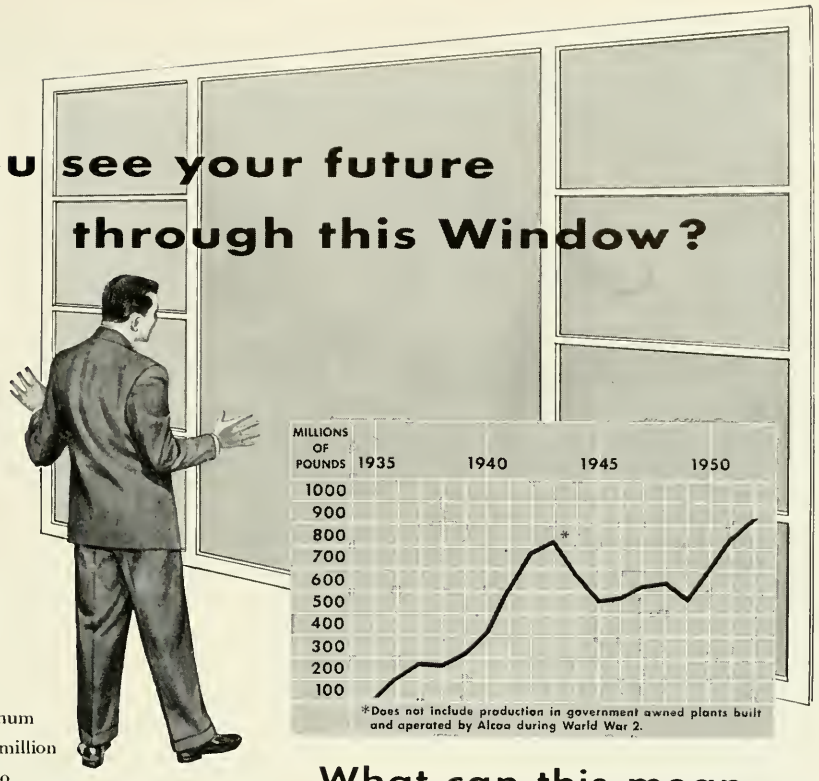
Can you see your future through this Window?



This is an aluminum window, one of four million that will go into buildings in 1953. Twenty years ago, it was just an idea in the mind of an Alcoa development engineer. Ten years ago, only a few thousand were made annually. Now, production *is increasing* at the rate of over half a million a year. This is just one of a torrent of new uses for aluminum which means that Alcoa must continue to expand. Consider the opportunities for you if you choose to grow with us.

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This is a production chart . . . shows the millions of pounds of aluminum produced by Alcoa each year between 1935 and 1952. Good men did good work to create this record. You can work with these same men, learn from them and qualify yourself for continually developing opportunities. And that production curve—is still rising, we're still expanding, and opportunities for young men joining us now are almost limitless.

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For more facts, consult your Placement Director. ALUMINUM COMPANY OF AMERICA, Pittsburgh, Penna.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

CHANCES ARE . . .

by Don Arnold, E.E. '55

Have you been gambling lately? When was the last time you walked across the street? That was really taking a chance that a car wouldn't turn a corner and run you down. Sure, we've all been gambling many times a day and on the simplest forms of everyday life.

Even if all of us do not have a close relation with the more recognized forms of gambling, occurences always turn up in which one of us is trying our new formula to try to beat the roulette table.

In November of 1947, two University of Chicago students rode out to Reno, Nevada, in an old beat-up car with $120 in their pockets. These students had figured a way to beat the wheel through a progressive parlay based on mathematical probability and two basic assumptions: (1) that any roulette wheel has some slight imperfection and follows a pattern of its own, and (2) that good or bad luck runs in streams. Night after night, anyone could see one of this partnership sitting by the roulette wheel feverishly taking down the winning numbers. Finally, they risked their first bet, using a system of increasing bets in a run of good luck but never decreasing bets. Before their streak of bad luck became prolonged, these two ran their $120 into $7,500. Here, they made the smartest play of their gambling career and went back to Chicago ahead by over $7,000.

This is just one lucky case of many who have tried to break the bank at the gambling halls. Not all stories have such a happy ending, and we are not trying to influence you to perfect a formula to beat the wheel. However, we would like to show some of the basis for the odds that you may read in the morning paper or to show you just what are your chances of beating the roulette wheel or some other gambling device.

Most odds are based on the simple laws of probability. For instance, if you have 3 pairs of trousers, 4 shirts, 2 pairs of shoes, and 2 sport coats, how many different ways can you dress. If you would try to figure out all of the different combinations, you would find that the answer is merely the product of the respective numbers, or $3 \times 4 \times 2 \times 2$, or 48 different combinations.

The same general principle would hold if you were giving odds on the chance of rolling a certain number on a pair of dice, say a 12. The chance of rolling a 6 on either die is one out of 6. Putting these two probabilities together, we have 1 out of 36, or 35 losses against 1 win. Thus the odds would be 35 to 1. Of course, if there is more than one combination of the dice that will give a number, the odds are greatly reduced. The odds against rolling a 7 on a pair of dice, for instance, are 5 to 1.

Have you been playing any cards over at your house lately? Well, the odds are 1 to 3 that you bought a deck of playing cards this year, and the odds are 2 to 1 that you will be playing bridge with them. If in this game of bridge, you and your partner hold 7 trump, you'll get an even split 36% of the time; if you hold 9 trump, you will get that even split 40% of the time; with 11 trump, you will get it 52% of the time.

If you have been betting on the football pools, you had better pick your teams carefully, because the odds are against you. Your chances of picking three winners are $2 \times 2 \times 2$, or 1 out of 6, while the cards give you 5 to 1. The chances of picking 10 out of 10 football winners are 1023 to 1, but you get odds of only 100 to 1.

Every spring the Kentucky Derby is run, and every race has its perennial favorite. Contrary to common belief, the bookmaker or race track does not set the odds on the horses, but the betters themselves cut their own throats through a system called parimutuals. Here the bettors make their own odds, and the race track takes a certain percentage of the total amount that is bet. Of course the state also takes its share of the bet so that less than 85% of the money bet on each race is returned. Hence, if a bettor would start with $10 and only get his 85% back on every race of an eight race card, he would only have $2.70 left at the end of the day.

According to the pari-mutual system, if $100,000 is bet on a race, the track and state take about $15,000. Now if 10,000 tickets were sold on this winning horse, each ticket would pay $\frac{\$85{,}000}{\$10{,}000}$ or $8.50. The odds are a little more complicated in computing the place (second) price, as two winners must be payed. Say that after the track and state has deducted its 15%, the total amount to be paid back to the bettors is $100,000. Thus $50,000 would be paid to the holders of tickets on the two winning horses. If 20,000 tickets are sold on one horse and 10,000 tickets on the other, the two tickets would be $2.50 and $5.00 respectively. The same system is used no matter how many winners are to be paid off.

As you can see the track doesn't care which horse wins the race because it always gets its same percentage and always wins. That is unless the minus pool is encountered. This is the situation that occurred nearly every time Native Dancer has run. The law requires that at least $0.05 must be paid back on each dollar bet on the winning horse. Thus in a hypothetical case let us say that out of the $100,000 bet on all horses in the race, $90,000 of it is bet on our winner, Native Dancer. If the state takes an eight per cent cut of the total amount bet, this would only leave $92,000 to be distributed to the winners. Since the track must pay back at least $1.05 for every dollar bet on the winner, a total of $94,500 must be paid back to the bettors, and the track must accept a loss of $2,500 on the race.

But what were the chances of our two University of Chicago students' beating the roulette wheel? The owner of the Monte Carlo Casino and the most played-on roulette wheel in the world said about the game, "Red wins sometimes; black wins sometimes; but white (the house) wins always."

A normal roulette wheel has 36 numbers and one zero. Of these 36 numbers, 18 are black and 18 are red. A player can wager that any certain number will

come up or that the winning number will be either red or black. The odds that any one of the 36 numbers (there are actually 37 spaces) will turn up is 1 out of 37, but the odds given are 35 to 1. The odds on one of the colors coming up are given at 1 to 1 when they are really 37 to 36 against your picking the right color. This means that for every $100 bet on a number at odds of 35 to 1, you can expect to get $97.30 back.

But these wheels are merely man-made instruments and every one must eventually have some minute flaw that will cause the wheel to spin untrue. It is on these repetitions that most of the gambling systems are based. This is why you can see the system player sitting by the roulette table with his notebook in hand trying to find the flaw that will show him he magic number that will defy the so-called law of averages and and appear more than the rest of the numbers.

There are many types of systems used by gamblers to apply the laws of probabilities to beat the roulette wheels. One known as the Martingale is to bet on a color and keep increasing the bet when losing so that when he finally wins, the winnings will more than cover all the losses. For instance, a player could bet one dollar on the red. If he loses, his next bet would be two dollars, and then four dollars, and eight dollars, and on up until he finally wins. Thus, if he wins on the fourth bet, he would receive $8, while he had lost a total of $7 on the three previous bets.

One of the big disadvantages of the Martingale is the limit set by the bank. If the player encounters a long run of losses, his progressive bets may reach the limit set by the house. Thus he suffers the maximum loss equal to the betting limit, and a series of maximum losses spaced close together will not give him time to recoup his losses.

Another system of this type is known as the Great Martingale. The bets after successive losses in this system are one less than the power of 2, or 1, 3, 7, 15, 31, 63, . . .

The effect of the zero in the Martingale is that it tends to increase the chance of an unfavorable run. To offset this additional strain, some players put a side bet on the zero. If no win is encountered by the fifth bet, the player would bet $1 on the zero while betting the usual $16 on, let us say, the red. If the zero would come up on this play, he would win $35, but will have lost $31 on the Martingale. If however, the black would appear on the fourth play, the player would increase his bet on the zero to perhaps $2, while his bet on the red would by the system increase to $32. Now if the zero would appear, he would still win a total of $7 on the series. If the red would come up on this sixth bet, he would be $1 out for the series and well able to start again. However, if the black would have come up again, the player must again increase both of his bets so that if he encounters a win, he can start again with little or no loss.

All of the basic systems are based on a combination of many of these principles, but there is one and only one system of play that most surely leads to winning even though the proceeds may be small. The kernel of this system depends upon finding a dishonest wheel. If you discover one that is being manipulated, it will surely be set so that the large bets will be lost. This is the time to bet opposite the large bets, and you are certain to win.

All of the odds stated depend upon a completely unbiased wheel which is mechanically perfect. But if the apparatus is defective, these odds cease to be true. If the machine so operates that its variation from the laws of chance are sufficient, a system may be worked out in which the odds of the game desert the bank and switch over to the player. It is this for which our notebook players and the two University of Chicago students are looking. So, engineers, whip out your slide rules, dust off your integral tables, interolate those logarithms, and chances are. . . .

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TECHNICAL WRITING GROWS INTO NEW PROFESSION

Publications Engineering

Reprinted with permission of the Institute of Radio Engineers from October 1952 "Proceedings of the I.R.E."

Robert T. Hamlett received his B.S. in Electrical Engineering from the University in 1928. His present paper first appeared in the "Proceedings of the I.R.E." for October 1952.

Summary—Engineering-level technical writing is described as requiring, foremost, the skills and knowledge of an engineer and, secondly, the ability to write well. For this combination of work the term "Publications Engineer" is proposed. The writer's participation in an engineering project is outlined on a time basis, starting with the sources of information and completed with delivery of the printed work. Satisfying aspects of the field are discussed and the future is predicted as of growing value to the engineering profession as a whole.

Introduction

The tremendous expansion in the size and productiveness of the engineering profession has been due, in a large measure, to the ability of research and development engineers to enlist other engineers for special tasks or services related to their basic problems. It was not so many years ago that an *engineer* was *the engineer*—he was charged with responsibility for all *engineering* work on a project. This was possible because the end result of his engineering work was usually a single unit or instrument which operated without "tie-in" or reference to other equipment. He found time somehow to solve all of the engineering problems that arose in connection with his "brain child."

But the modern era of "systems" rather than "instruments" has changed the engineering approach to a very marked degree. One hears now about systems engineers, product engineers, project engineers, standards engineers, administrative engineers, test engineers, field engineers, production engineers, packaging engineers, industrial engineers, and so on. What has happened? Simply that the individual engineer cannot any longer carry all the burdens of the job of "engineering" of a system or even of a single instrument which ties into a system. While a very gifted engineer, possessing high skill in many branches of engineering, may still be able to visualize and guide the work on his project, he is no longer able to carry on the many individual investigations, attend the frequent engineering conferences, plan the fiscal and field-testing programs, solve the production and packaging problems, or create the publications which are necessary.

This ability of the engineer to pass on responsibility to other engineers has given rise to still another field of specialization within the engineering profession—that of TECHNICAL WRITING. (See Fig. 1.) The products of this new field are instruction books, training manuals, engineering reports, technical data sheets, and many other types of technical information, a sampling of which appears in Fig. 2. The workers in this field are referred to as "Technical Writers," "Engineering Writers," "Specification Writers," "Technical Report Writers," and the like. This author prefers to call the workers in this field "Publications Engineers," in keeping with other well-established titles such as "Standards Engineer," "Test Engineer," and "Field Service Engineer." This new title will be used throughout the article.

What Is a Publications Engineer?

The principal reason why this author prefers the new title "Publications Engineer" to that of "Technical Writer" is that it more clearly designates the duties of such a worker, and also places him in a proper professional status with fellow engineers, where he rightly belongs. For he is an engineer first, and secondly a writer. The term "Technical Writer," as commonly accepted, refers to a writer who writes material on technical subjects to various levels of intelligence but who is not usually concerned with the actual publication processes and problems.

The Publications Engineer is an engineering specialist who relieves other engineers of the major portion of the responsibility for production of all publications required as a result of the engineers' work. The Publications Engineer writes technical material, plans and directs preparation of copy, and carries through on all details concerned with actual production of the publication. It is necessary to repeat that he is first an engineer, then a writer, and finally, a publication man.

Engineers have always labored under the stigma that they cannot write well. It is a common attitude, even in pre-college education, to assume that because

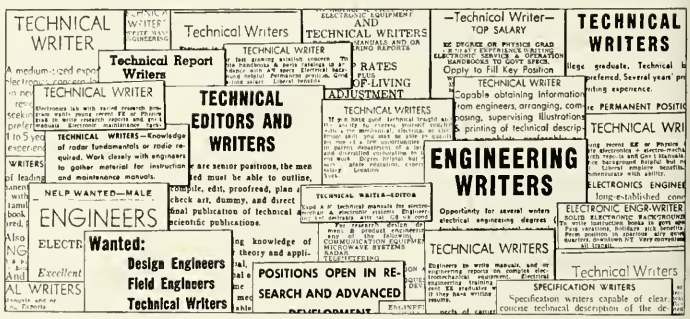


Fig. 1—Demand for engineer-writers, identified herein as publications engineers, is evidenced by these classified advertisements selected at random from employment sections of newspapers and magazines.

the student is superior in mathematics he must be inferior in English. This affects the student's attitude and he very naturally uses it as an excuse for not seriously studying the subject in which he is prejudged to be inferior. When the "superior" math student goes to engineering school, it is a foregone conclusion that there is very little that can be done to help him there. However, he is given one or possibly two courses in English (especially "arranged" for engineers) early in his college work. No further attempts are made to help him overcome a deficiency which will handicap him throughout his entire career.

There is no doubt that some engineers cannot write—but some lawyers, some accountants, and some doctors cannot write well! Some doctors do not develop a pleasing "bedside" manner, so they become fine surgeons or specialists. So some engineers do not take time to write well, and because of this other engineers now find an interesting and well-paid profession.

The Publications Engineer must be an engineer who has writing aptitude. This aptitude may have never become very obvious because of the misguidance and lack of encouragement received during his education. The author has seen many engineers, who felt certain that they were below average in writing aptitude, develop into excellent writers of technical material. No one can doubt that the engineering profession would be in a much better position if there were more effective writers among us. (The same might be said for speakers.)

The Publications Engineer must be an engineer with unquenchable thirst for learning. If he is a mechanical engineer, he must be learning more about electronics; if he is an electrical engineer, he must be learning about aerodynamics, hydraulics, and the like. He is constantly challenged to describe something about which he knows practically nothing. But with his basic engineering education under his hat, he tackles each unknown with some confidence that he can understand and interpret it for others who may know more or less about it than he does. Many fine technical descriptions result when engineers who are educated in one field begin to write on subjects in other engineering fields; they use analogies which help the reader in applying the description to his own experience.

Fig. 2—Publicotions engineers produce a variety of matter requiring skills of both engineer ond writer.

The Publications Engineer must have a working knowledge of the advantages and disadvantages of many types of reproduction processes, such as spirit duplication, mimeograph, Photostat, blueline, and blueprint, Ozalid, and offset printing and letterpress printing. He is familiar with type faces, paper stock, cover materials, binding methods, and the like. He understands the problems involved in production of copy by typewriters, Varitypers, typesetting, and phototype. He has a practical knowledge of the arts of photography and retouching, and he guides technical illustrators in visualizing and rendering special illustrations for use with his written words.

All of his talents and acquired knowledge are combined in the process of preparing a publication that must meet government or commercial specifications covering content, format, practicability, and literary standards. He is at the same time an engineer, a writing specialist, a publications expert, and a student of psychology!

When the young Publications Engineer has overcome his inferiority complex in tackling new writing projects, he finds the variety of writing assignments to be one of the most attractive features of his job. It is a familiar complaint among engineers that they become too specialized and know too little of what is taking place in the scientific world around them. While no scientist can hope to keep abreast of the tremendous evolution of technical achievements now taking place, the Publications Engineer finds real satisfaction in testing and adding to his knowledge in many different fields. As an eample, in the author's company the skilled Publications Engineer develops a descriptive knowledge in such varied fields as radar, hydraulics, servomechanisms, gyroscopics, computing mechanisms, ballistics, optics, navigation, and aerodynamics. When the occasion demands, he becomes, for a time, a writing specialist in one or more of these fields.

In addition to the variety of writing from the product standpoint, there is also much variation in the material to be gathered on any one product or system. Fig. 3 illustrates some of the writing assignments on a single system. Some of the assignments require the Publications Engineer to work intimately with the equipment; in some cases he com-

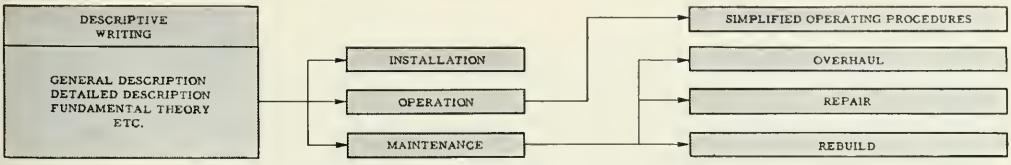
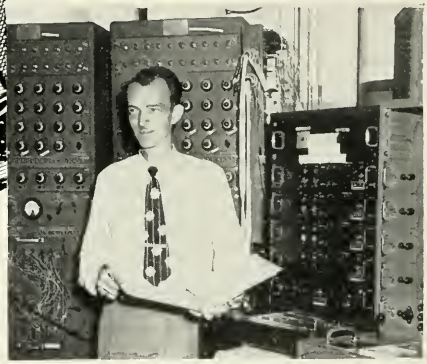


Fig. 3—Publication engineer's writing begins early with a project and follows product into the field.

NEEDED--- A NEW APPROACH!

HE HAD ONE



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BOBBIE S. SHARRAH
Assistant Chief Dynamics Engineer — Missile Engineering Division
B.S.A.E. IOWA STATE COLLEGE '45
M.S. APPLIED MECHANICS WASHINGTON UNIVERSITY '52

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McDONNELL *Aircraft Corporation*

letely disassembles and reassembles the nits. In other cases, he accompanies the quipment on trial runs or field tests. 'hese experiences give a "practical" itisfaction to those who like to feel that ıey are not just "theoretical" wriers.

Another attractive feature of the Pubcations Engineer's work lies in the ariety of contacts which he makes in ıe course of the development and approval of a publication. Fig. 4 shows typical "life story" of an instruction ook prepared for the Armed Services. 'he underlining in the diagram gives ı indication of the many individuals ncerned in the preparation or approv- of the publication prior to its final rinting; the Publications Engineer orks constantly with all of those ıown.

The Future for Publications Engineers

Young engineers often raise the ques- on as to the future of Technical Writ- g or Publications Engineering. There re several factors which appear to be of nportance in attempting to predict the ıture—but to the auhor they all look ıvorable toward increasing opportunity r this new profession. First, the com- lexity of equipment and systems cer- inly will continue to increase; auto- ıatic control is the utimate goal of early all future instrumentation, and ith such control always comes increased chnical complexity. With increasing mplexity there is greater need for more mplete instructional material. As one ssociate put it, "the equipment becomes ıore complex but the intelligence of the verage user remains the same." Second, ranted that complexity will increase, ıere is the immediate following con- ition that the equipment will be much ıore costly and must be repaired rather ıan replaced. This adds again to the ed for publications which will be ade- uate for the purpose. The funds allo- ated for publications will necessarily ıcrease, but will still be a very small rtion of the total cost of the equip- ent. Third, if the caliber of engineer- g graduates coming into Publications ngineering is maintained or raised, ıere will be a broadening in the scope f their work since they themselves will evelop opportunities for using their ecial skill to supplement the work of her engineers. This is a very important sponsibility in any new profession—to evelop and broaden the particular skills d to offer them to others.

Conclusion

Publications Engineering is a new rofession which has grown rapidly in ıe past few years because of the in- reasing complexity of equipment and ıe inability of the research and devel- pment engineers to undertake the ex- nsive writing projects which became necessary.

The Publications Engineer must have a sound engineering education and must possess writing aptitude—although it is pointed out that the possession of this aptitude may not be realized by many young engineers.

The Publications Engineer develops a knowledge of the reproduction and printing processes, and can guide the publication through all of its stages from rough draft to its printed form.

The variety of work assignments and personal contacts appeal greatly to certain engineering graduates. Some of the writing arrangements cover theoretical aspects, others are along practical lines where the writer works closely with the equipment in the factory or in the field.

The "personal-satisfaction" factor is quite high for the Publications Engineer since his assignments are usually of short duration, compared to those of the engineer, and he "sees" the final results of his labors at more frequent intervals.

Finally, the future of this new profession looks promising because of the trend towards more complex equipment and the accompanying requirements for more complete handbook and engineering report coverage. The future also depends upon the efforts which Publications Engineers make to find new areas of service to the engineering profession.

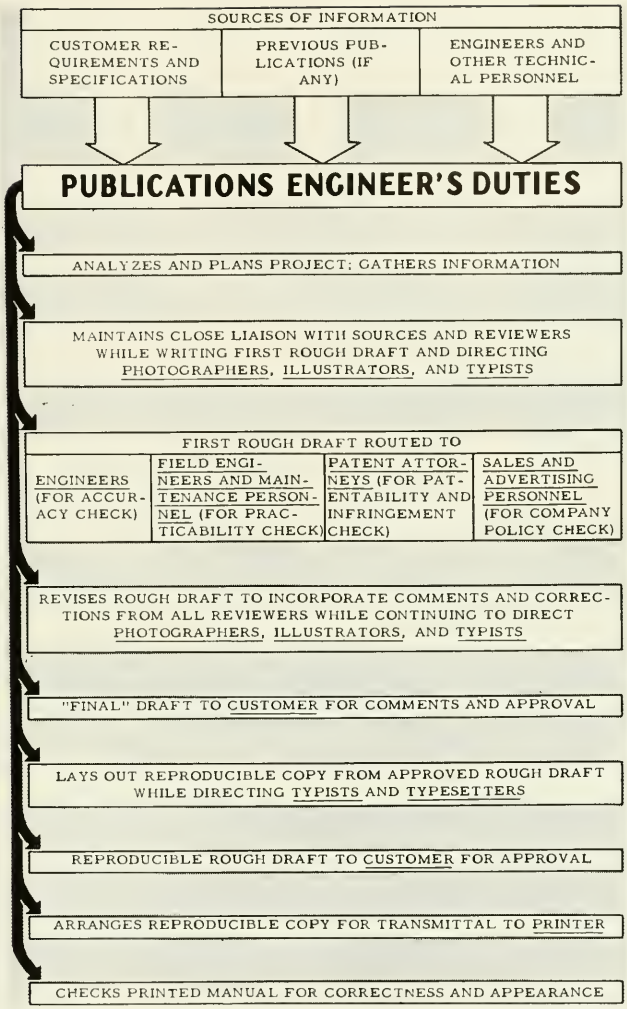
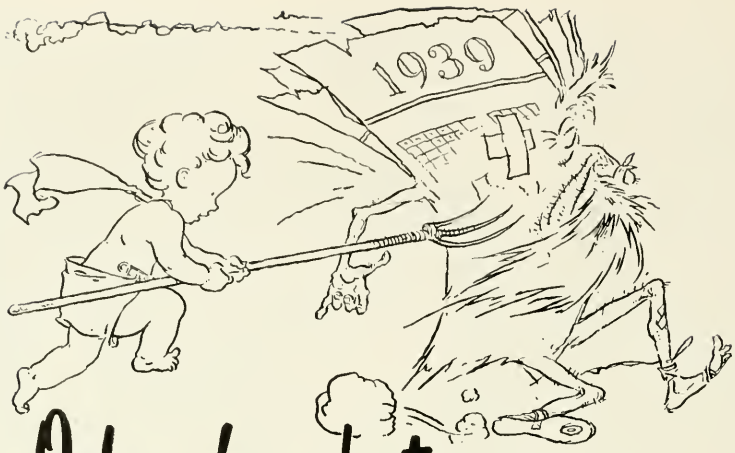
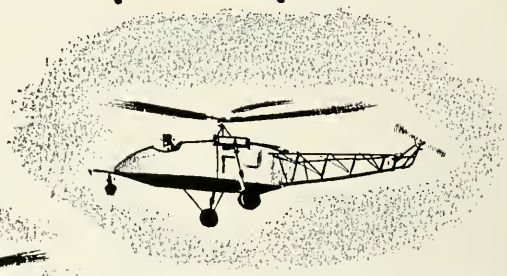

SOURCES OF INFORMATION
CUSTOMER REQUIREMENTS AND SPECIFICATIONS
PREVIOUS PUBLICATIONS (IF ANY)
ENGINEERS AND OTHER TECHNICAL PERSONNEL
PUBLICATIONS ENGINEER'S DUTIES
ANALYZES AND PLANS PROJECT; GATHERS INFORMATION
MAINTAINS CLOSE LIAISON WITH SOURCES AND REVIEWERS WHILE WRITING FIRST ROUGH DRAFT AND DIRECTING PHOTOGRAPHERS, ILLUSTRATORS, AND TYPISTS
FIRST ROUGH DRAFT ROUTED TO
ENGINEERS (FOR ACCURACY CHECK)
FIELD ENGINEERS AND MAINTENANCE PERSONNEL (FOR PRACTICABILITY CHECK)
PATENT ATTORNEYS (FOR PATENTABILITY AND INFRINGEMENT CHECK)
SALES AND ADVERTISING PERSONNEL (FOR COMPANY POLICY CHECK)
REVISES ROUGH DRAFT TO INCORPORATE COMMENTS AND CORRECTIONS FROM ALL REVIEWERS WHILE CONTINUING TO DIRECT PHOTOGRAPHERS, ILLUSTRATORS, AND TYPISTS
"FINAL" DRAFT TO CUSTOMER FOR COMMENTS AND APPROVAL
LAYS OUT REPRODUCIBLE COPY FROM APPROVED ROUGH DRAFT WHILE DIRECTING TYPISTS AND TYPESETTERS
REPRODUCIBLE ROUGH DRAFT TO CUSTOMER FOR APPROVAL
ARRANGES REPRODUCIBLE COPY FOR TRANSMITTAL TO PRINTER
CHECKS PRINTED MANUAL FOR CORRECTNESS AND APPEARANCE

Fig. 4—Publications engineer gains broad knowledge of product, its engineering, manufacture, and application. Persons with whom he consults directly are underscored in this diagram of manual's life cycle.

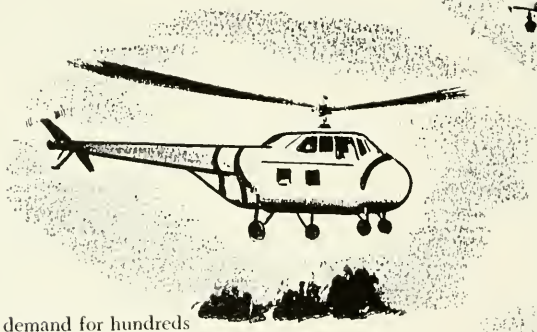


Only a few short years ago

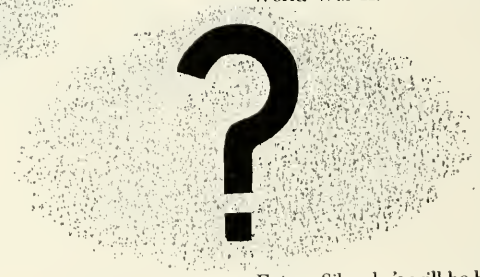
the helicopter was thought to be a "stunt" machine — amazing and amusing, and not particularly important. Events in Korea changed that idea — fast! This fledgling among aircraft performed "impossible" military assignments, spectacularly successful missions of mercy. Helicopters came into their own.



In 1939, the VS-300 with Igor Sikorsky at the controls made the first practical helicopter flight in the United States. Hundreds of later Sikorsky's were delivered for service in World War II.



Now in demand for hundreds of jobs, today's most versatile flying machine is the product of ceaseless testing, highest-calibre engineering, work and imagination.



Future Sikorsky's will be built by tomorrow's engineers. Perhaps *you* belong at Sikorsky where your skill and ability will be continually challenged.

You might find — in Sikorsky Aircraft's research departments, drafting rooms, engineering laboratories — a lifetime opportunity in this young, growing and most interesting field of aviation. Write today to R. C. Banks, Personnel Department.

SIKORSKY

Sikorsky Aircraft, one of the four divisions of United Aircraft Corporation, South Avenue, Bridgeport 1, Conn.

SAVANNAH RIVER PROJECT . . .

by Sandra Rains, E. Physics '57

SANDRA RAINS. This is Sandra's first article for the Technograph. She is a freshman this year in Engineering Physics, and comes to the U. of I. from Hutsonville, Illinois. Sandra is quite interested in technical and plans to take journalism courses along with the standard engineering program.

In late 1950 the AEC (Atomic Energy Commission) first made public its plans for building the United States' largest nuclear energy installation. The plant, which was to be called the Savannah River Project, was to be constructed near Aiken, South Carolina.

Temporary headquarters building of the Savannah River Project.

The site chosen for the project is in a rural part of South Carolina. A section of land twenty miles square containing approximately 315 square miles was bought by the government. The 6000 people who lived here were evacuated immediately. With the exception of the 800 people who lived in Ellenton and Dunbarton, all of the people had to leave farms which had been in their families for generations. This particular site was chosen because it met all technical and defense requirements, notably for space and seclusion.

Most of the land was heavily wooded and hilly, so the first job was to clear it. This was the initial step in the biggest construction job since the Panama Canal. In fact, this is the biggest industrial project ever undertaken from scratch.

The plant which was to be built here was not, presumably, to be a location for the manufacturing of hydrogen bombs. It is supposed to turn out the materials which can be utilized for bombs elsewhere. However, since the experimental explosion of a hydrogen bomb in Eniwetok last November, there has been little doubt in most peoples' minds that the principle business at SRP will be the manufacturing of hydrogen bombs. This will include the making of triple-weight hydrogen called tritium, which now has to be recreated since it no longer exists in nature. The AEC is being very careful to assure the people of the three counties involved in the SRP that they are in no danger. One hydrogen bomb could wipe out 300 square miles.

E. I. du Pont de Nemours & Company have the government contract for the plant. They started work January 11, 1951. In only the last few months has work progressed enough to be confidential. Now it is almost impossible to get inside the section. Credentials are checked at every stop, and there are many different projects scattered over the section which no one is allowed near. From a distance, all that can be seen are tall steel structures. The one building that can be entered is a starfish-shaped construction which is the temporary administration building. Cameras, field glasses, alcoholic beverages, and other things of this type are banned from the site. As work progresses further, the security veil will be drawn even tighter. The government remembers how our atomic secrets were stolen, and they do not mean for that to happen again.

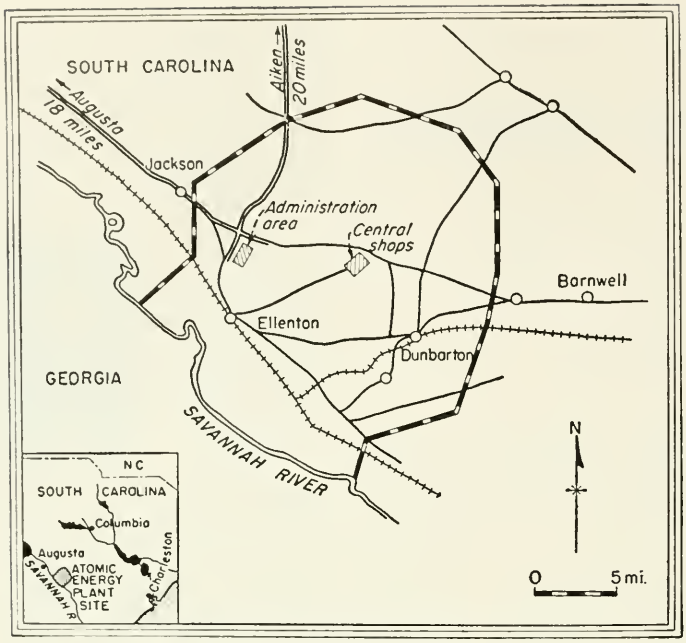
The exact nature of the work at SRP is not known. The estimated total cost for the whole operation is $1,500,000,000. The only other information which has been disclosed is the amount of supplies which will be required to finish the project. They will use 75,000,000 board feet of lumber, 1,250,000 cubic yards of concrete, 85,000 tons of reinforcing steel, and 25,000 tons of structural steel. They are excavating 20,000,000 cubic yards of earth, drilling 60 drinking wells, stringing 95 miles of electric lines, laying 66 miles of railroad track, constructing 105 miles of new roads, and building 250 factory, laboratory, office, and other buildings. Six thousand, three hundred trucks and other vehicals are being used daily. After the plant is in operation, over a billion gallons of water a day will be taken from the Savannah River for use in some of the operations.

The AEC owns all SRP lands and buildings and has control of the overall policies, but the construction, operation, and design of the project is left completely up to the Du Pont Company. Du Pont is handling most of the major portion of the work itself, but certain specialty jobs, such as highway and railroad construction, have been sub-contracted.

A small staff of AEC officials has been stationed at the project site to keep check on standards and costs. They also act as liason between the Du Pont Company and Government agencies. Their main job, however, is to see that the project progresses according to schedule.

Total employment for the construction of the plant has reached 45,000 men. After the plant is completed it will require a staff of 7,500 to maintain it. In September of 1953, the weekly payroll of all employees has reached $3,000,000, making the yearly payroll about $150,000,000. It is hoped that

Temporary worker housing for SRP construction crews.



Map of Savannah River Project.

after the plant is completed, the annual payroll will be $30,000,000.

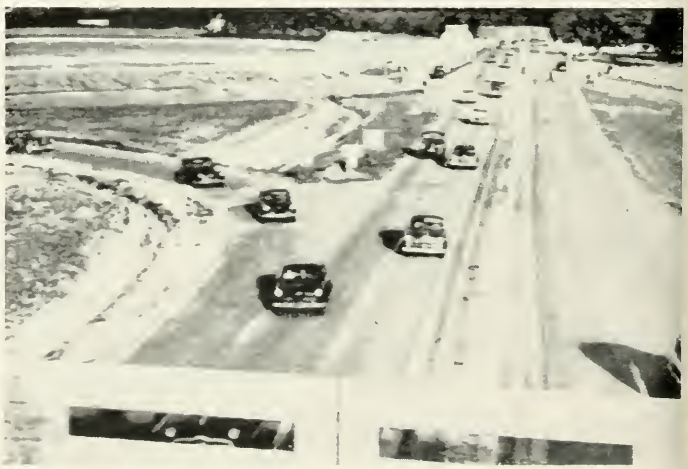
With the 45,000 men employed have come their families, so that over 120,000 people have invaded this small community in the last two years. About 30% of the people employed are from outside South Carolina and Georgia. The AEC decided it would be best not to establish a government town as they had at Oak Ridge, because the difficulties were thought to be disproportionally large in relation to the small part the towns played in furthuring atomic research. It was to be left to private enterprise in the Aiken-Augusta area to furnish food and lodging for the workers. As a result, this sleepy part of the country has been completely changed. The population has almost doubled, while the money in the local banks has increased by about one-third. Over 7,000 trailers dot the country side, and pre-fabricated houses spring up over night. Hotel reservations must be made at least ten days in advance. The schools and hospitals are becoming increasingly overcrowded, and the water and sewage systems have not proved capable of accommodating this huge increase in population. It is felt by a large number of people that it would have been wiser to have established a government town. They have asked the government for aid, and have received some help, but certainly not a sufficient amount. The AEC has tried to hire civic-minded people in their permanent staff, so in many ways the living conditions have been bettered.

There is only one large town near the site, and this is Atlanta, Georgia. However, they have not been largely affected by the plant due to the river separating them from South Carolina. There is no bridge in a place to make commuting satisfactory. Before the plans for the plant were announced, a bridge was being planned; but now the advisability of such a structure is being debated.

Work on the SRP is divided into two general phases; the construction of the factories and the operation of the plant after the manufacturing of atomic material starts. These two phases overlap considerably. The employment of the permanent staff was started in the middle of 1952 when construction employment was at its peak. Even after the main construction is finished and the plant is in operation, some construction will continue, meaning that there will be a permanent construction crew, as well as operating staff.

Although excellent wages and good working conditions have prevailed, the Du Pont Company has had much difficulty in hiring workers. Liberal training programs and a nine-hour day and a five-day week are offered. Also, a good safety program, one thing in which the Du Pont Company is outstanding, is in effect. Many people have not been hired because of health and security reasons, and racial discrimination has been another major problem. There has been a serious shortage of qualified engineers, skilled laborers, and clerical help.

The United States now has in their possession the largest hydrogen bomb plant in the world. Through the combined efforts of the Atomic Energy Commission and the Du Pont Company, promises to be one of the most successful ventures of modern times.



Part of the stream of workers' autos entering the project area during its construction phase.

Engineers Today – Executives Tomorrow

by Wilbert Stoecker

Clifford Strike, president of F. H. McGraw Company.

Thirty-five years after receiving his degree in electrical engineering from the University of Illinois, Clifford Hood became president of Carnegie-Illinois Steel Company and vice-president of operations of United States Steel Company.

Hood's slide rule now lies buried somewhere beneath inter-office communications, business statistics and reports. One out of every three of Hood's fellow graduates in engineering likewise has progressed to a position of management.

WILBERT STOECKER, M.S., is an instructor in the Mechanical Engineering Department.

Most of the courses that the engineer takes in college train him to be an engineer—not a manager whose concern is primarily with human problems. Looking forward to the time when he will sit behind a manager's desk, the student in engineering can begin his study of human relations by the choice he makes in his non-technical electives.

About thirty per cent of all engineers are in administration and management according to "Employment Outlook for Engineers," a 1948 bulletin of the United States Bureau of Labor Statistics. The percentages of some of the branches of engineering in administration are as follows: Chemical, 29.1; Electrical, 28.4; Mining, 41.6; and Mechanical, 32.0. Civil engineers have contributed the greatest percentage of supervisors with 47.5 percent in management. This percentage includes the 18 per cent of the civils who are supervising construction.

As if these figures are not impressive enough, the census-takers confessed that they had no way of knowing how many men, trained as engineers, listed themselves as vice-presidents, executives and managers.

More than four hundred of the top nine hundred executives in the country studied engineering or science in college, according to a 1952 survey made by *Fortune Magazine*. These men earn an average salary of $70,000 to $80,000 a year. *Fortune* says: "Many of the big companies have become too vast for a specialist in law or finance or engineering to manage. Men in these fields have reached the top. . . . because they possessed a broad view of the companies activities, and an ability to get along with people."

It took Clifford Strike just seven years after he was graduated from the University of Illinois in mechanical engineering to become vice-president of a construction company. Today, Strike is president of F. H. McGraw Company, international constructors and engineers. His company handles some of the largest construction projects in the world. Because each company has only about one president, all engineers can't be presidents like Strike and Hood. But there are many administrative jobs at all levels, such as project leaders and foremen, which require some of the same qualities needed by the president and vice-presidents.

In each succeeding year after a class graduates, more and more of its engineers join the supervisory ranks. Engineering graduates of the University of California reported that the longer they have been out of school, the greater is the likelihood that they are administrators. Table 1 shows this progressive increase in administrators.

Almost all of the engineers who are in administration supervise technical activities, reports the Bureau of Labor Statistics. No doubt these men hold administrative positions primarily because they have had technical training. Nevertheless, their chief concern gradually becomes *people*, rather than things. These engineers - turned - administrators must now get things done—not by doing the work themselves, but by having others do it.

What can the engineering student do while in college to prepare himself for possible managerial duties? He can choose his electives from the humanities and social sciences, and thus he can increase his consciousness of human nature.

A knowledge of human problems is a must for managers, according to Clarence Randall, chairman of Inland Steel Company. He says, "To be worthy of management responsibility today, a man must have insight into the human heart, for unless he has an awareness of human problems, a sensitivity toward the hopes

TABLE I

Years from Graduation	Percent in Administration *Mech. Engr.*	*Mining & Met. Engr.*
0-5	2	1
5-10	7	7
10-15	19	19
15-20	34	25

Clifford Hood, Electricol Engineering, 1915.

and aspirations of those whom he supervises, and a capacity of anlysis of the emotional forces which motivate their conduct, the projects entrusted to him will not get ahead no matter how often wages are raised."

The social sciences offer an excellent opportunity for a systematic study of human beings and their emotions. Sociology is the study of group behavior, whereas psychology concerns itself primarily with the individual. A good course in history will necessarily examine the behavior of groups as well as individuals. You cannot study history without realizing that social changes are always taking place. Thus you become alerted to shifts in moral and social standards that are going on around you.

Literature courses can be beneficial electives. Often literature is good because the author has a keen insight into human nature. A good author can capture the spirit of his time, and the book becomes popular because it expresses the sentiments of a large body of readers. The arts have their place in stimulating a richer enjoyment of life, but they are not ordinarily an aid in professional advancement.

Within the College of Engineering there are several courses, officially classified as non-technical electives, which study human relations in industrial situations. These courses deal with the operation of a company and the supervision of its workers.

In several of the engineering curriculums at Illinois, the stuent can choose between a technical or a non-technical elective. Probably those who would profit most from an L.A.S. course prefer to stay on familiar, technical ground. Even when a non-technical course is prescribed, some students take an L.A.S. course in a physical science for fear that any subject which does not involve mathematics will poison the mind.

You need not expect any miracles to happen after you have taken several courses in the social sciences. These courses are but a step in heightening your awareness of human problems and emotions.

Many well-meaning people have said that engineers should solve human problems with the same logical approach that they use in engineering. The fact is that the ability to analyze the stresses in a column or beam does no necessarily equip an engineer to settle a thorny dispute in his plant. Human beings will often be controlled by prejudices and sentiments; therefore, the engineer must always be conscious of the emotions of the people with whom he works.

"Now then, Johnny," said the teacher, "I want to give you a little problem. Suppose there were five children and their mother had only four potatoes to share between them. She wants to give each child an equal share. How would she do it?"

"Mash 'em," said the boy.

* * *

"I was so cold last night I couldn't sleep."

"And did your teeth chatter?"

"I don't know. We don't sleep together."

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THIS NEW FLASH POINT TESTING MACHINE is so accurate that a sample with as little as 1/10 of 1% unsafe material in it will cause a rejection. Recently developed by Standard Oil's Engineering Research Department, this revolutionary device reduces the average time from 20 minutes for a flash test to two and a half minutes, avoids human errors in testing flash point, can be used right at the loading rack.

Adventures in Research

The flash point testing problem that was solved with the machine shown above is only one of the many problems presented to Standard Oil's new and growing Engineering Research Department.

In the last few years, it has developed and put into operation instruments to measure vapor pressure, 158° point, acidity and viscosity. Ultrasonic generators have been built for general use in providing energy for experimental purposes. The department is studying application of radioactive isotopes to instrumentation and control problems related to refinery operation.

One of our research divisions is carrying out an extensive theoretical study of stresses in pressure vessels having flat, conical, hemispherical, toriconical or torispherical heads.

In our work on product evaluation, we have developed a new test for quenching oils based on the fundamental heat transfer relationships involved.

Problems such as these are the daily fare of Standard Oil's Engineering Research Department. Here is a challenging opportunity for young men with advanced training in chemistry and engineering. Many and varied problems continually arise in the design, construction and operation of petroleum industry equipment.

Standard Oil Company

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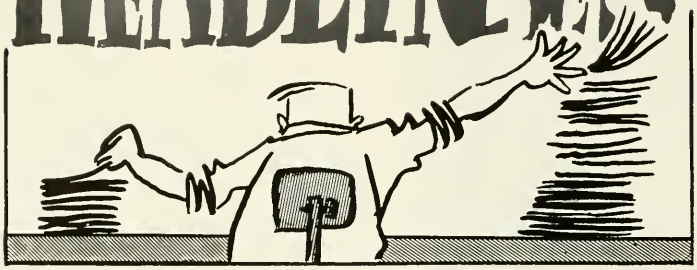
STANDARD

SKIMMING INDUSTRIAL HEADLINES



by Chuck Foley, M.E. '55

Ball Bearing Retainers

Precision bearings capable of attaining speeds in excess of 100,000 rpm are now possible through the use of thermosetting laminated plastics. As manufactured and fabricated by Synthane Corporation of Pennsylvania, retainers for machine tools, grinding spindles, turbine and supercharger blowers, and aircraft instruments can be machined within the tolerances required for precision and super-precision bearings.

The comparative light weight of laminated plastics provide bearing designers with a number of advantages over metals. Due to the smaller masses involved, centrifugal forces resulting from extremely high speeds are reduced, and as a consequence, there is less friction and wear against adjacent metal surfaces. Laminates, while virtually impervious to oils and greases, do absorb small quantities of lubricant during machining, and therefore, the bearing has self-lubricating characteristics.

Electron Toughened Containers

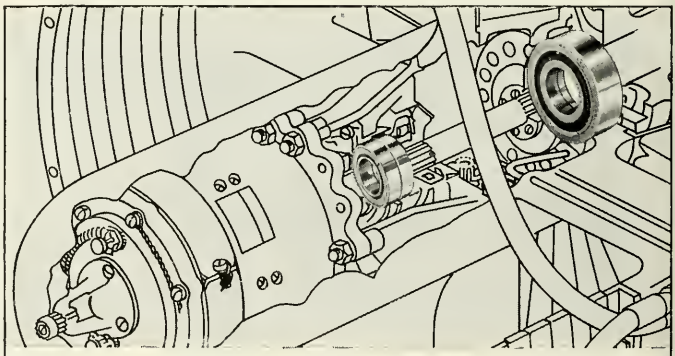
The electron, already one of man's most versatile servants, now can toughen flexible plastic containers to withstand steam and can prevent certain plastic dishes from wilting in the hottest automatic dishwasher. Dr. C. G. Suits, G-E vice president and director of research, has stated.

The newly found method for "curing" plastics cross-links long, chain-like molecules called poylmers which make up these plastics. A few second's bombardment with electrons from a million-volt X-ray machine makes polythelene bottles stand up under steam-sterilization. This toughening permits more widespread use of these containers for packaging and storing pharmaceuticals and biological fluids. The latter include blood splasma, which formerly could be carried only in bulky, easily sterilized glass.

Pint-Sized Atom Pile

A pint-sized atomic pile, "little brother" to the big ones used to make plutonium for atomic bombs, has been placed in operation as a research tool at the Knolls Atomic Power Laboratory, Schenectady, N. Y., which is operated by the General Electric Company for the Atomic Energy Commission.

The new low-power nuclear reactor, in contrast to huge reactors at the company's Hanford Works, Richland,



Turning Points in Jet Engine Design

Designing more power into less space . . . a trend in jet engine development . . . puts a premium on space-weight saving factors as well as performance. That's one reason why jet engine designers are specifying more and more Fafnir Ball Bearings for every important turning point from main rotor to accessories and gear boxes. Fafnir Ball Bearings save space and weight as well as meet performance requirements established for the latest type jet engines. By keeping in step with aircraft progress, Fafnir continues to lead in the production of aircraft bearings. The Fafnir Bearing Company, New Britain, Conn.

AVAILABLE

A sound-motion picture depicting high points in the manufacture and use of Fafnir Ball Bearings is available to engineering classes. Write to The Fafnir Bearing Company, New Britain, Conn., for details.

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Wash., is contained in a cube of graphite measuring only five feet on a side.

While a low-energy reactor of this sort cannot be used for making plutonium, or for the production of atomic power, it is a useful source of the atomic particles called neutrons, which can be utilized in many fields of fundamental research.

Indoor Electrical Highway

Electronically-controlled dynamometers provide an indoor highway for automotive testing at the Ford Motor Company's new Research and Development Center, Dearborn, Michigan. The dynamometers were built by Westinghouse Electric Corporation.

The ability of these dynamometers and their associated equipment to simulate many road conditions, such as inertia, wind resistance, and road grades, has made it possible to move automotive proving grounds indoors for many tests.

New Hot Strip Mill

A new 66-inch semi-continuous hot strip mill, one of the fastest of its type in the world, has begun operation at the Allenport, Pa., Works of the Pittsburgh Steel Company.

The hot strip mill is part of a $62,800,000 expansion program designed to place the company in the flat-rolled products market. Pittsburgh Steel in the past has been known primarily as a producer of ingots, seamless-tube, and wire products.

The new mill, using four finishing stands, has a rated top speed of 1770 feet per minute and is expected to produce 600,000 tons of strip and sheet steel annually. Provisions have been made to accommodate two additional finishing stands in the future which will raise the mill's speed to 2230 feet per minute.

Rubber Tired Railroad

A rubber tired locomotive and freight car combination dubbed and capable of economic operation over pathless desert sands or cheaply constructed roads has been unveiled by the R. G. LeTourneau of Longview, Texas.

The heart of the Tournatrain is an "electric wheel," which carries a large pneumatic tire and has within its rim an electric motor and gear reduction. These electric wheels are being built in different sizes to take tires from 5 to 10 feet in diameter.

Every wheel of the Tournatrain is a rubber tired, self propelled electric wheel. The electric wheels derive their energy from the locomotive which mounts diesel engine driven electric generators. The Tournatrain engineer, from his cab on the locomotive, applies power at will to all wheels of the Tournatrain. In this way each freight car provides propulsion for its own load—each car of the Tournatrain pushes and pulls at the same time. There are no brake shoes to wear out because the same electricity that drives the wheel can be used to hold it back going down hill. Only an automatic spring loaded brake is provided for emergency.

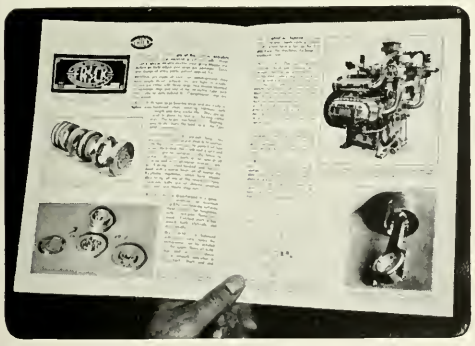
Each car is coupled to the car ahead of it in such a way that it follows in the same tracks. By a simple automatic steering device the path of the locomotive is duplicated in its turn by each of the train so that the locomotive can pull up to a street intersecion and make a right angle turn and every car will come up to the same spot and make the same turn.

Higgins: I don't blame you for being sore at McTavish for running off with your wife."

Biggins: "It isn't that. It is the idea that the old skinflint had to wait until I bought her a set of new false teeth."

* * *

Small boy explaining broken window to policeman: "I was cleaning my slingshot and it went off."



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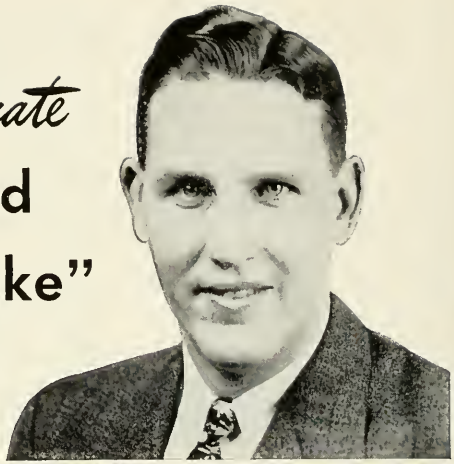
"Allis-Chalmers Graduate Training Course Helped Me Find the Work I Like"



says HUGH C. SELLS,
Syracuse University, BS—1942
and now Manager, Knoxville District Office

"I guess I was like many graduating engineers. I didn't really know what I wanted to do. When the Allis-Chalmers representative visited the campus, and described their Graduate Training Course, it sounded like the type of postgraduate training I really needed.

"What appealed to me then—and still does—is the broadness of the program. Here is a company filling a unique spot in industry. It makes important, specialized equipment for almost any industry you can name."

Wide Choice of Activity

"It's like a big department store for industry. But that isn't all! In addition, it offers a wide choice of activity within each of these many product groups . . . whether it be sales, design, research or production.

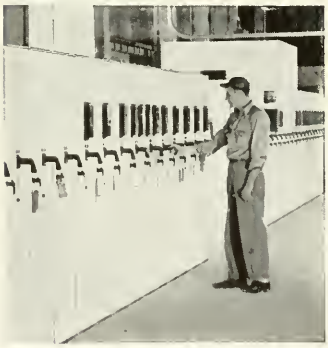
"After getting the broad look at industry the program offers, my interest began centering on Service and Erection of large equipment. This led me into many departments of the company, and I learned about everything from steam turbines to sifters for flour mills."

Valuable Background

"The transition from service to sales was natural. The background of service and erection work proved very valuable.

"So you see, whether you think you know what you want to do or not, the Allis-Chalmers Graduate Training Course is so flexible, so broad in its scope, you have a real chance to find yourself. Best of all, you don't have to waste time doing it."

ELECTRONICS—Modern way to dry sand cores is with Allis-Chalmers *Foundromatic* Sand Core dryer. Revolutionary new process dries cores in minutes instead of hours.



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Facts You Should Know About the Allis-Chalmers Graduate Training Course

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2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

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4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

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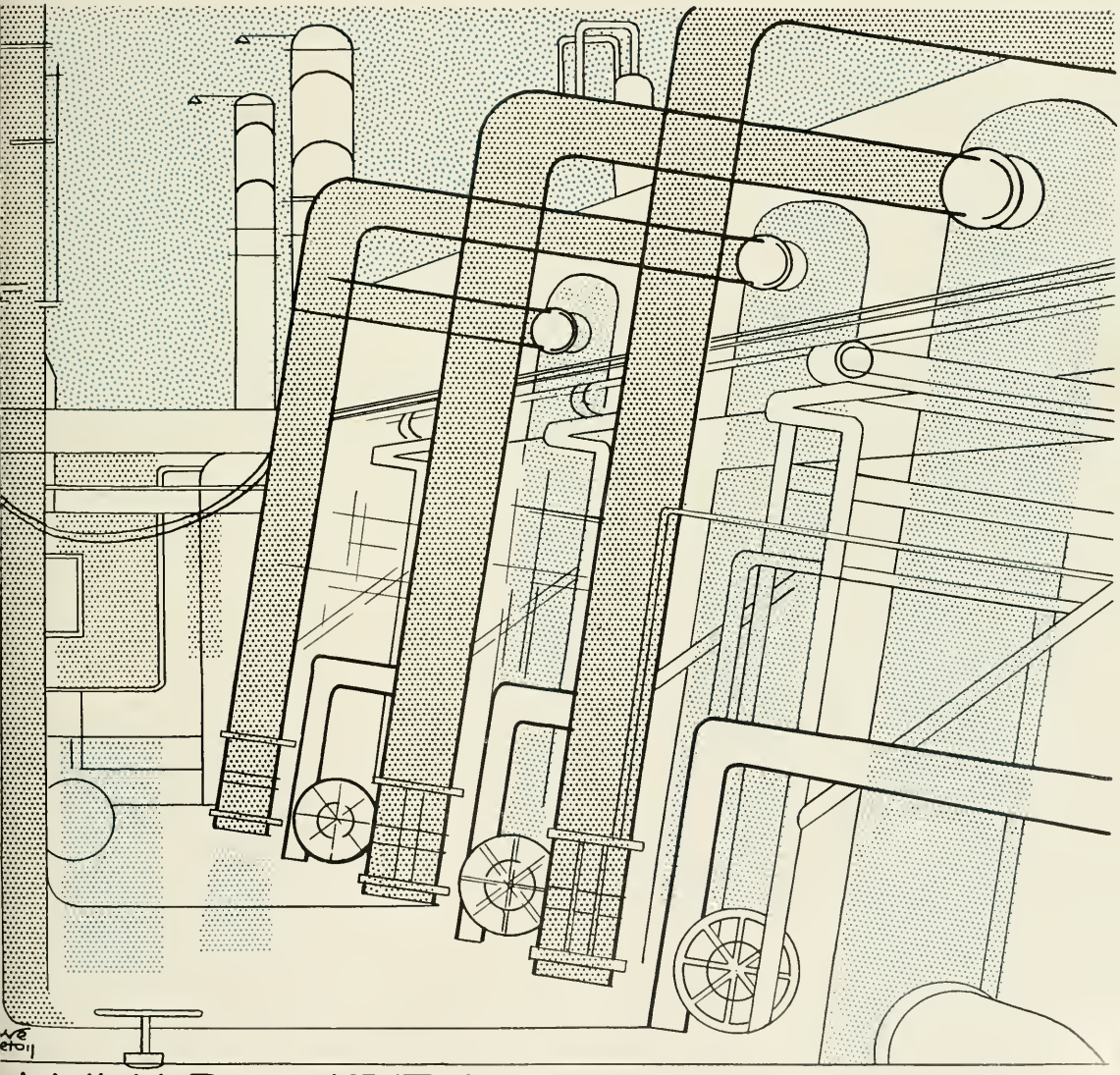
ILLINOIS TECHNOGRAPH



ANUARY 1954

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Published eight times during the year (October, November, December, January, February, March, April and May) by the Illini Publishing Company. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois, under the Act of March 3, 1879. Office 213 Engineering Hall, Urbana, Illinois. Subscriptions $1.50 per year. Single copy 25 cents. Reprint rights reserved by *The Illinois Technograph.* Publisher's Representative—Littell Murray-Barnhill, 605 North Michigan Avenue, Chicago 11, Ill. 101 Park Avenue, New York 17, New York.

THE ILLINOIS TECHNOGRAPH

volume 69 number 4

contents:

chicago areo expressways ____ 9
national petro-chemicols plant ____ 15
sigma phi delta ____ 19
the E. E. in government ____ 21
alpha chi sigma ____ 24
robert ollerton park ____ 28
triangle ____ 32
the centrol district filtration plant in chicago ____ 37
aerosol research ____ 42
abbott power plant ____ 45
boneyard bilge ____ 49
new law campus ____ 51
skimming industriol headlines ____ 54

our cover

The engineer often sees his projects and achievements only in the light of their functional operotion. However, the artist can often see the beauty in the lines and curves of these functional pieces. Compore the cover with the photo on page 16 ond you can readily see how the ortist interpreted the grace and form of the refracting towers. This cover is by Dove Templeton.

our frontispiece

The Cabinet Gorge hydroelectric development on the Clark Fork River in northern Idaho wos completed lost year by the Washington Power Company. The first of four 500-000-kw generating units was on the line just 21 months after stort of construction of the 208-foot high, 600-foot long dam. (Cut courtesy of Westinghouse)

● Wallace L. Carr was graduated from the University of Illinois with a B.S. degree in Electrical Engineering in 1951. After a short time with a large electric utility—where he was Junior Engineer in substation design—he came to Allison where he is presently Electrical Engineer in the plant engineering department, Aircraft Engine Operations.

Wally's job in this department varies from designing plant, lighting, and power layouts, and machinery electrical diagrams to electrical and instrumentation layouts of turbo-jet and prop-jet test cells. With a multimeter, he is shown above checking the thermocouple circuits on the control panel in one of the Allison test cells.

In jet cells, it is necessary to simulate all engine controls that appear in a jet plane, plus other controls which are necessary to check and evaluate engine performance . . . operating temperature . . . acceleration . . . speed . . . fuel consumption . . . oil flow, etc.

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There's a future for graduates at The Detroit Edison Company—a career opportunity best described by the fact that many of the executives in the organization at this time began their climb to success in positions similar to those offered graduates today.

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Chicago Area Expressways

by Warren H. Brandt, C.E. '54

The Chicago area expressway system comprises six major arteries entering the Central Business District or its vicinity, these are:

1. North Route Expressway—the existing Lake Shore Drive from Sheridan Road south along the lake shore to the downtown area, including the new extension from Foster Avenue to Hollywood Avenue which bypasses the famous Edgewater Beach Hotel.

2. The Northwest Route Expressway—from the new Chicago International Airport south of Des Plaines, Illinois to the junction with the West Route near Halsted and Van Buren Streets; this includes the much publicized Eden's Expressway, the greater part of which is out of the Chicago city limits, and the Erie Street Distributor which will tap some near-north business district traffic.

3. The West Route Expressway—better known as the Congress Street Expressway this route has been in the planning stage for some time.

4. The Southwest Route Expressway—a limited access facility to be located in the bed of the old Illinois-Michigan Canal.

5. The South Route Expressway—a superhighway to join the completed Calumet Expressway to the West and Northwest Routes at the aforementioned interchange near Halsted Street.

6. The Southeast Route Expressway—the present Lake Shore Drive from the Central Business District to the Indiana State Line.

The present status of these projects ranges from the drawing board to completed job. Much of the completed work is outside the limits of the city of Chicago. This is explained by virtue of the fact that this work in many instances could proceed without the necessity of removing many structures as had to be done in Chicago.

Progress on Expressway projects:

North Route

The North Route has been completed for several decades. The newest extension designed to by-pass the bottleneck at Foster Avenue and Sheridan Road was opened to traffic in October, 1953. The extension carries northbound traffic to Byrn Mawr and Hollywood Avenues where it again enters Sheridan Road.

WARREN H BRANDT

Warren graduated from Lane Technicol School in 1942. He spent two years at Navy Pier before coming to the Urbana campus. He is now a senior in Civil Engineering and is a member of ASCE and the Institute of Traffic Engineers.

The ultimate designs envision a lake front road to the Evanston city limits, however, considerable planning will be necessary before this facility can be extended. The plans would provide access to the major east-west streets which now terminate at the lake shore. Such a route would greatly assist traffic moving from the far north side of Chicago into the Loop.

Northwest Route

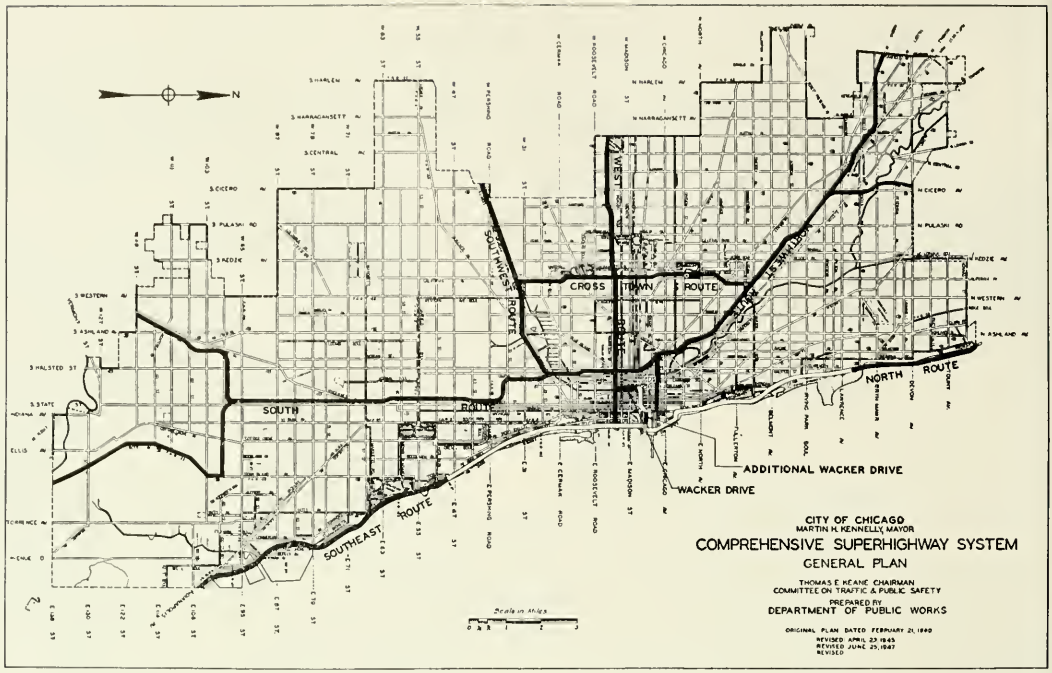
The route taps a potentially heavy volume of traffic to the multi-million dollar improvement at the Chicago International Airport, a city-owned property, three miles outside the city limits and 18 miles northwest of the Central Business District (the Loop). The construction on this route has not commenced although there is extensive clearing of expressway property north of the junction with the West Route. A tentative completion date of 1963 has been set for this route.

A portion of the route running parallel to the old Skokie Highway called the Eden's Expressway has been open to traffic for about two years. It is a modern facility with mercury-vapor luminaries along its entire length.

Signing on the Eden's superhighway is rather attractive. Most of the signs have reflectorized green backgrounds with white vertical block letters. The visibility of the signs is very good as is necessary on a high-speed roadway of this type.

The Northwest route includes a cross-town connection to the North Route which utilizes two near-north-side streets. These streets serve as distributors to the two routes and will expedite traffic flow in that area of the city lying immediately north of the Chicago River.

Eden's Expressway interchange with West Touhy Avenue on Chicago's northwest side.



West Route

The West Route is better known to Chicagoans and others by its popular name—the Congress Street Expressway. This project has occupied the attention of city planners for some time and is in the advanced stages of design and construction.

Outside the city limits many of the bridge structures are completed and a small section about a mile in length is to be paved early in 1954. Certain sections in Forest Park, cut through cemetery properties and right-of-way acquisition is proceeding slowly.

In the city of Chicago all the right-of-way has been cleared of any obstructions. The clearing serves a two-fold purpose in that it creates a green-belt through the heart of the city and clears extensive lower class and slum areas.

Many of the bridge structures in the city have been completed and contracts are being let for others as rapidly as plans are made available. Several of the structures were designed by private structural design firms and novel designs have resulted from their efforts. The governmental bodies responsible for the highway felt that by varying the design of the structures aesthetic considerations could be satisfied to a greater degree. They are to be commended for their foresight in this matter.

Eden's Expressway southern terminus at North Cicero Avenue near West Foster Avenue. The Edens superway connects with the planned Northwest Route about a mile south of this point.

Portions of the Expressway in the Central Business District have been completed. These are all grade intersections and cross major north-south thoroughfares south of the Loop. A cut through the LaSalle Street Station is underway as is a beautiful twin-bascule bridge spanning the Chicago River east of the United States Post Office.

Portions of the Expressway west of the Post Office have been completed. These include a wide ramp supported on piers and an underpass at Canal Street. The ramp construction is shown in the photograph and involved tremendous quantities of structural steel.

The city of Chicago expects to spend about $10 million to complete its portion of the work. The project costs about $100 million and the remaining shares are financed by the State of Illinois, the Cook County Highway Department and the U. S. Bureau of Public Roads. Most of the funds are derived from gasoline taxes.

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No matter what your military status, it's worth inquiring about Bell System employment opportunities. Your Placement Officer has the details. And be sure to talk to our employment representatives when they visit the campus. The time to plan your future is now!

BELL TELEPHONE SYSTEM

Moving second truss span into place on the Calumet Expressway.

Southwest Route

The Southwest Route will lie in the bed of the old Illinois and Michigan Canal. This canal which was the first in Illinois was constructed in 1848 and handled considerable tonnage until the construction of the Sanitary and Ship Canal in 1900. The Sanitary Canal parallels the older canal on the north for much of the way to the Illinois river.

The present I-M Canal, as it is abbreviated, is in a poor state having been neglected for many years. In some places the property has been filled-in and permament structures erected upon it. The property until a short time ago could not be sold. It was the property of the United States until an act of Congress gave it to the state of Illinois thus releasing Federal claims on the land. Sale of parcels was prohibited by the original legislation providing for the construction of a canal and requiring that the canal be kept in operation for the movement of United States troops. State acquisition of the Canal nullified these requirements.

Expressway plans for the Canal superhighway have been partially completed. The Canal and its towpaths occupy a right-of-way, called the Reserve usually 300 feet in width which is entirely adequate for an expressway. The route would tap a potentially heavy residential area on Chicago's southwest side.

South Route

The South Route, which is in the planning stage, will connect with the West Route at the Halsted Street Interchange. It will run due south paralleling South Halsted Street for much of the way. Eventually the route connects with the completed Calumet Expressway near Lake Calumet on Chicago's far south side. Publicity on this route has not been very prolific and its completion is probably ten or twenty years in the future. Demand plays an important part in expressway construction.

Southeast Route

This facility has been completed for some time. It is the existing Lake Shore Drive and boulevard system southeastward along the lake shore to the Indiana state line. Attention to this route has recently been enlivened by the notice that preliminary sudies for the Indiana Turnpike located the terminus of the Turnpike at the extreme south end of the Southeast Route.

The route is not a limited-access facility and would require huge quantities of money to make it so. The right-of-way widths are extremely variable in some cases only the customary 66 foot city street width is available.

Additional Studies

High-type facilities constructed with motor fuel tax funds by their very nature require considerable time for construction which is generally dependent upon the availability of the necessary monies to finance the project. This delay has resulted in agitation in some circles for a toll-road type of development with the consequent speedup of funds and accelerated construction schedules. Some studies are underway at the present time under the auspices of the Illinois Toll Road Commission to construct expressway facilities as toll roads through and around Chicago. Tentative routes utilize portions of the planned expressway system, mainly the South Route and the Northwest Route. If constructed these routes would be operated as toll roads and would join with other free expressways such as the West Route and the Southwest Route. The toll collection structures at these junctions can create some major problems.

Another toll road route would utilize the alignment of present state route 83 in bypassing the city. Studies of the origin and destination of through drivers will have to be made in order to justify the construction of a road of this type. Bypass routes in the past have not been too successful due to subsequent development of commercial facilities along their rights-of-way.

Expressway construction on the West Route, looking west from the Post Office. Shown in the foreground i s an approach ramp that spans three streets. The route continues westerly from this point for twelve miles. (Photos courtesy Illinois Division of Highways.)

NATIONAL PETRO-CHEMICALS PLANT

by Alan England, E. Physics '54

Just thirty odd miles south of the campus, near Tuscola, Illinois, a plant of one of the newest and fastest growing industries has recently made its debut. This industry, the petrochemicals industry, uses the byproducts found in natural gas to produce a great variety of liquified gases and industrial chemicals in staggering quantities. This plant is owned and operated by the National Petro-Chemicals Corporation which was formed in June of 1951 by the National Distillers Products Corporation in partnership with the Panhandle Eastern Pipeline Company.

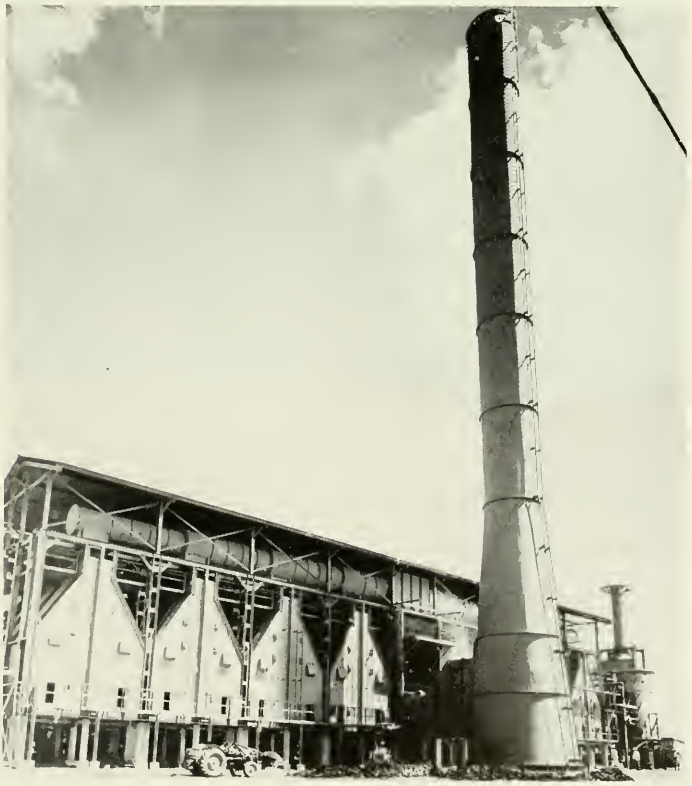
The operation and maintenance of the plant is carried on by a group outstanding for enthusiasm, initiative, and ability. Men from thirty-one different companies averaging twelve years of experience form the supervision. The stability of the group is indicated by the fact that the number of previous employers per individual averages 1.2. The average age of these men is thirty-five years. They include graduates from twenty-eight different colleges and were drawn from nineteen different states and four Canadian provinces.

Tuscola was a natural choice for the location of the plant since it is a junction point for two major gas transmission systems from western Kansas and the Gulf Coast, and also since the transportation facilities to and from suitable market areas were already available. The plant site was chosen in September 1951 and construction began in October 1951. To design the buildings and units that would cover the 442 acres of land, four major contractors with four hundred engineers and designers labored for a full year.

Tremendous quantities of materials were used in the two years of construction. Enough steel plate to cover nineteen acres one-quarter inch thick was shipped in, enough concerete to build a sixteen mile highway was poured, enough aluminum to provide 24,000 sauce pans was needed, enough copper to run a single power line 156 miles was used exclusive of motors and generators, and enough other material to put a noticeable dent in the national debt was found necessary for the construction.

ALAN ENGLAND

Alan is one of the new members of the Technograph staff, having joined this fall. His article on "Radar and Your Weather Report" appeared in the November issue. He is a senior in Engineering Physics.



The 170 foot stack in the National Petro-Chemicals Corporation ethylene plant is the tallest structure in the new $50 million complex dedicated November 11 ot Tuscola, Ill. Temperotures exceed 1400 degrees F. in these ethane cracking furnaces.

For such a large scale operation, it was found convenient for the company to provide their own power. The power plant has three boilers which produce 600,000 pounds of steam per hour. The generating capacity of this unit, 12,000 kilowatts, can be compared with the 7,500 kilowatt requirement for a city the size of Champaign. The power out put of the University of Illinois Power Plant is also 12,000 kilowatts. A coal crusher and conveyor system readily handles the 800 tons of coal per day necessary to feed the boilers from a large stockpile.

The wate rsupply for the plant represented an acute problem due to the large quantities necessary for such large scale operations. Since the supply from the Kaskaskia River, a small stream adjoining the company property was not sufficient to handle the industrial operations during dry periods, a large underground supply some distance from the plant was tapped. During the two to three months of the year when the natual supply is not adequate, two large pumps will supply water to the river from this underground source. The river will carry the water to the plant where it is stored in an artificial lake covering twenty-five acres and holding 100,000,000 gallons. Water is needed at the plant at the rate of 1,100 gallons per minute. Water from the lake first goes to a treatment plant to soten, sterilize, stabilize, and demineralize the water and remove the suspended material from it. Industrial and sanitary wastes are well treated before they are returned to the Kaskaskia River. This treatment removes the source of all possible contamination and returns the water to the river in a purer form than it was taken out.

The hydrocarbon extraction unit processes 400,000,000 cubic feet of natural gas per day. Twenty-one million cubic feet of desirable hydrocarbons are removed from this stream, the remaining volume being returned to the Panhandle Eastern Compressor Station. The extraction of the saleable hydrocarbons is accomplished by first dehydrating the natural gas to remove any water, followed by absorption in a refrigerated two-oil absorber system. The absorbed gases are liquified and then pumped to the Fractionation Unit for separation and purification.

The extraction plant of the National Petro-Chemicals Corporation plant located at Tuscola, Illinois.

The Fractionation Unit is charged at a rate of 750,000 gallons per day with these liquid hydrocarbons. This liquified petroleum gas is composed of ethane and propane with lesser amounts of butane and natural gasoline. Ten million cubic feet of ethane is recovered from the fractionating towers per day and is then delivered to the Ethylene Unit to be converted or "cracked" to ethylene. Four hundred thousand gallons of propane, 80,000 gallons of butane and 19,000 gallons of gasoline are also recovered from the fractionating towers and are sold directly as liquid fuels. The ethane delivered to the Ethylene Unit is converted at 1500 degrees Fahrenheit in specially designed cracking furnaces. Hydrogen and heavy hydrocarbons are produced along with the ethylene, the hydrogen later being used in the Ethyl Chloride Unit.

In this Unit, hydrogen and chlorine are combined to form hydrogen chloride in special non-corrosive carbon furnaces and then the ethylene and hydrogen chloride are brought together in the presence of a catalyist to form crude ethyl chloride. The finished production of ethyl chloride is 50,000,000 tons per year. The Synthetic Alcohol Unit produces 125,000 gallons per day of 192 proof alcohol, thirty per cent of all the synthetic alcohol produced in the United States. Twelve thousand gallons of ether per day are produced as a by product. This process involves the absorption of ethylene gas in sulphuric acid to form a mixture in a series of alloy lined steel columns at elevated pressure. The mixture is then reacted with water to produce crude alcohol in sulfuric acid. The alcohol is separated from the acid and is purified in copper distillation columns. By products of this step are ether and isopropyl alcohol. Weak surfuric acid remaining from this process is concentrated and is fortified at a nearby sulfuric acid plant so that it may be reused.

The U. S. Industrial Chemicals Co., has built a sulfuric acid plant near the petro-chemicals plant. Sulfur is shipped up the Mississippi from Louisiana by barge. It is delivered in gondola cars and stocked in a 5,000 ton pile for later use. In production it is loaded into a melter by crane. From the melter it is burned at a rate of 100 tons per day and the resultant sulfur dioxide is changed to sulfur trioxide by contact with air in the presence of a catalyst. Part of this gas is used to strengthen the weak black sulfuric acid from the Alcohol Unit. The remainder of the gas is contacted with weak fresh acid to manufacture 98% white acid for shipment to other consumers. The total capacity of the plant is 300 tons of 100% sulfuric acid, 100 tons being used for the Alcohol Unit, the remainder being sold.

Naturally, the storage facilities for a plant such as this are very large. One interesting storage method used for propane is underground storage in limestone-sandstone stratum deep below the ground. Three hundred thirty feet down and eighteen feet thick, the limestone stratum beneath the Tuscola plant will be reached by a twelve foot verticle shaft. From the bottom, horizontal tunnels will be dug that will be able to hold 6,000,000 gallons. The propane may be pumped in for long storage and when removed will be dry and unchanged in quality. This method of storage cuts the cost of storage to about a third compared with surface methods.

Engineering Social Fraternities . . .

Sigma Phi Delta

by Dick Wharton, M.E. '54

"The promotion and advancement of the engineering profession and engineering education, the instilling of a greater spirit of cooperation among engineering students and their organizations, the inculcation in its members of the highest ideals of Christian manhood, good citizenship, obedience to law and brotherhood and the encouragement of excellence in scholarship" is the objective of Sigma Phi Delta Fraternity. The motto: "Pro bono professionis," which translated from the latin means, "for the good of the profession," further bears out the objectives of this international fraternity of engineers.

Alpha chapter of Sigma Phi Delta was founded at the University of Southern California on April 11, 1924, making this fraternity one of the youngest of the national fraternities. Delta chapter was established at the University of Illinois on January 25, 1928. There are eleven active chapters in existence today. They are located at the University of Southern California, University of Illinois, North Dakota State College, Marquette College, University of British Columbia, Chicago Technical College, Tri-State College, Indiana Technical College, University of California at Los Angeles, University of California at Los Angeles, University of California and Manitoba University. Prior to World War II, active chapters were also located at the University of South Dakota, University of Texas, and Tulane University. These chapters were forced to withdraw from the fraternity during World War II, as did many chapters of other national fraternities during the war, when membership was a critical problem.

The publications of Sigma Phi Delta are of two types. The *Star* an esoteric bulletin, is issued quarterly to members, active and alumni, to keep them abreast of news and new ideas. The *Castle*, the official magazine, is an exoteric publication devoted to educational and informative articles and stories and serves to give members an outlet for their journalistic talents. Recently, policy has been revised to publish articles by outstanding non-member authorities and the *Castle* will be made available to engineering school libraries on a broader basis. Thus, it is hoped, Sigma Phi Delta can even make a greater contribution to the advancement of engineering education.

Engineers are good bookkeepers. They know, or quickly learn how to keep their financial house in order. It is not an exaggeration to say that no chapter of Sigma Phi Delta has been in serious trouble because of financial difficulties. The wants of the average engineering student are moderate, hence fraternity life for them is not a costly item. Housing corporations managed by alumni, not the national organization, are the landlords and keep a sure and steady eye on chapter property and its upkeep. Never once has a housing corporation reneged on its obligations; and although loans have been made to several of these corporations, not a nickel has ever been lost. Every venture has been a calculated business proposition.

Science, Friendship and Duty is the interpreted significance to the members of Sigma Delta of their Greek letter name. Delta chapter, the Sigma Phi Delta chapter at the University of Illinois is located at 1103 West Illinois Street in Urbana. As an example of the way in which Sigma Phi Delta Fraternity attempts to inculcate in its members the principles of Science, Friendship and Duty, let us examine the activities of Delta chapter through the media of these three terms.

A few statistics will bear out the fact that Delta chapter has preserved as its primary motivation the pursuit of scientific knowledge. In the spring and fall semesters of the school year 1952-53, the overall house scholarship rating was ninth out of 56 fraternities at the University of Illinois. The pledge scholarship rating for these two semesters was, surprisingly enough, higher still; seventh out of the same number. In each case, Sigma Phi Delta was in the top 20 per cent of all fraternities on campus. Furthermore, during this same period 42 per cent of the men living in the chapter house had semester averages above 4.0. Further evidence of academic excellence is supplied by the fact that, of the men now in the chapter house, 23 per cent have financial assistance to honorary societies; and, 48 per cent through scholarships; 32 per cent belong hold offices in professional or honorary societies, some having as many as four such positions. The fact that the engineering student at Sigma Phi Delta can readily obtain consulation with, and advice from his older brothers in his studies, no doubt bears a significant influ-

Group photo of the members of Sigmo Phi Delta.

ence on the high scholastic rating of this fraternity in engineering schools.

The strong bonds of friendship that exist between members of Sigma Phi Delta are augmented by a small, (by comparison with social fraternities), but adequate social program. Normally one semi-formal and two informal dances are held each year. There is no limit to the number of social activities in which the chapter may partake; however the members usually chose to keep the number of social activities at this level in order to keep pace with the work load required of an engineer. This type of arrangement, in which the student can plan his social life in accordance with his studies, gives him the broadened culture necessary to assure entrance into post college life without being "flat on one side."

A program of professional talks on technical and non-technical subjects and an occasional inspection trip complement the purely social activities to provide a well balanced social program. This professional program, which is required by the fraternity's laws, is broad in scope. It includes forum discussions, symposiums, and addresses. The subjects considered are by no means restricted to engineering and thus frequently provide the broader contacts which professional social fraternities sometimes fail to provide. The speakers most often requested are the chapter faculty members, consisting of Professor H. E. Babbitt, Civil Engineering; Professor M. S. Helm, Electrical Engineering; Professor A. R. Knight, Electrical Engineering; Professor F. G. Straub, Metallurgical Engineering; Professor P. Torda, Aeronautical Engineering; and Professor C. C. Wiley, Civil Engineering.

Inspection trip scene at the Wabash Railroad yards at Decatur, Illinois.

The bonds of friendship are also exhibited on the playing field where "Sig Phi Delt" participates in all, and excells in few, intramural sports. As a rule, engineering students are poor athletes. Not because they are puny and weak, for as a matter of fact they are pretty rough and ready specimens, but because long hours in the classroom and laboratory, coupled with term long assignments on a single problem such as a concrete arch bridge or the design and layout of an entire power plant are not compatible with the shrill sound of a coaches training whistle.

The last letter of the fraternity name stands for Duty; implying duty to the engineering profession, duty to the school is exhibited by the fact that the chairman, the secretary-treasurer, and one of the five members of the Central committee of the 1954 Engineering Open House, and the chairman and treasurer of the 1954 St. Pat's Ball are Sigma Phi Delta men.

Sigma Phi Delta offers no apology for its existence. It has a worthy program with high ideals. It is striving to carry out this program and live up to these ideals. It is not necessarily the best fraternity, for who can say what the best fraternity is or should be? But, Sigma Phi Delta is a young, growing fraternity with a high quality membership, worthy leaders, and a driving desire to realize its own objectives.

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The E. E. in Government

by Charles Runyan
E.E. '57

Many of you have chosen to be Electrical Engineers, but even E. E. is a wide field. Just what phase of "E.E." do we want to major in? Making the choice is a prodigious step, and the choice is yours, and yours alone. The greatest decisive factor is the opportunities of each phase of engineering. Consider what types of jobs are available for each. Will they sui tthe individual needs? Do they compare with other fields? One phase of "E.E." is Communications, which has many opportunities to offer. Communications is a growing field with more and more openings every year. Because radio equipment is so complex, many skilled personnel are required, not only to perform maintenance, but to instruct, install, and design this equipment. The greatest outlet of communications equipment is the Armed Forces, and with the Armed Forces, the Civil Service Commission offers many excellent opportunities for the communications engineer.

Qualifications for Civil Service

In order for the communication engineer to work for civil service, he must be a citizen of the United States, a college graduate or equivalent, and at least 21 years old. All appointments are made on a competative basis, and all applicants are subjected to a rigid civil service examination. The results of these exams are studied, and only those qualified are appointed. Adequate results on the examination do not necessarily mean an appointment. Primary emphasis is placed on an oral interview, where appearance, voice, poise, and bearing of the applicant count heavily. The facts are evaluated by the Civilian Personnel Office in regards to all appointments. A college graduate with little experience will probably start as a GS-5 with an automatic promotion to GS-7 at the end of 6 months satisfactory service. This rating has a $5,400 annual salary. If an engineer has a good background with experience he may receive a rating of GS-9, 10, or higher depending upon his qualifications.

Type of Work in Civil Service

A wide variety of jobs are offered in Civil Service depending again, upon the individual preference and ability. The best openings are in the service technical schools. Instructors, technical representatives, writers, maintenance, and supervisors are needed to head the departments and staff the school. In a service school military and civil service employees work side by side. Due to the rapid turnover of military personnel, a nucleus of civilians is maintained. Course supervision as well as academic program layout are some of the responsibilities of the civilians working for the government. Students attending a school of this type are taught, tested and evaluated, and promoted by civil service employees along with the military. A high degree of respect is shown the civil service instructor.

Service Technical Schools

The world's largest communications school, located at Scott Air Force Base, Illinois, is divided into three main departments: the fundamentals branch, airborn radio, and ground radio equipment. The fundamentals branch primarily teaches basic radio theory and concept correlated with laboratory work. During this course students construct their own transmitter and receiver along with other various equipment. The student is taught International Morse Code in addition to the fundamentals of communications. The airborne and ground courses are more advanced schools, where students specialize in certain communication equipment. The school is 36 weeks in duration, and is divided into a number of smaller departments or phases. Each phase is from four to five weeks long, each of which function as a separate unit.

The Technical Instructor

The staff of instructors includes both military and civilian. Civilians often train new military instructors, who highly desire this assignment. The supervisor, usually a GS-9, merely checks on the instructors assigned to his team, and maintains a high level of instruction as well as a smooth running organization. The course writer keeps all technical data up to date and make changes whenever necessary in the course curriculum. He may be the phase technical advisor who conducts phase training classes with the instructors to answer any problems arising from the technical material. Next is the classroom instructor who is the most important, for he molds the future communication men, the backbone of any military organization. An instructor conducts classes and laboratory, and may be assigned to any one of the phases to teach. His classes usually run about 10 to 15 students. He lectures and gives them individual assistance in the laboratory. He is the one who teaches communications. The classes are six hours long and are usually divided into three hours lecture, three hours laboratory. Each hour is 50 minutes long allowing 10 minutes for relaxation.

Instructor Training

When an appointment with civil service is made, the appointee is assigned as a special student and must attend special classes on methods and techniques of teaching, technical training, and other courses of special training. No individual is allowed to get "stale, since all instructors rotate to different phases of instruction. This along with promotions to jobs requiring supervisory skill are available for the Civil Service employee.

There are many openings with the Government in the field of Communications and Electronics. Opportunities and advancement are available, so why don't you future engineers look into the future. Now!

Austin Bush, Rensselaer, '50, Helps Develop New Pump

AUSTIN BUSH, inspecting stuffing box assembly on boiler feed pump.

Reports interesting project engineering assignments at Worthington

"Despite its size as the leading manufacturer in its field," says Austin Bush, "I have found Worthington pays considerable attention to the interests of the individual. The company's excellent training program consists of several months of working with the various types of equipment manufactured, augmented by technical lectures, and talks on the organization of the corporation.

"Following this training, I was given an opportunity to choose the department in which I wanted to work—engineering, sales, or manufacturing. My choice was the engineering department where I have already been assigned to several interesting projects.

"In addition to the training program, the members of our engineering department hold monthly seminars at which engineering topics of general interest are discussed.

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When you're thinking of a good job, think *high*—think *Worthington.*

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, New Jersey.

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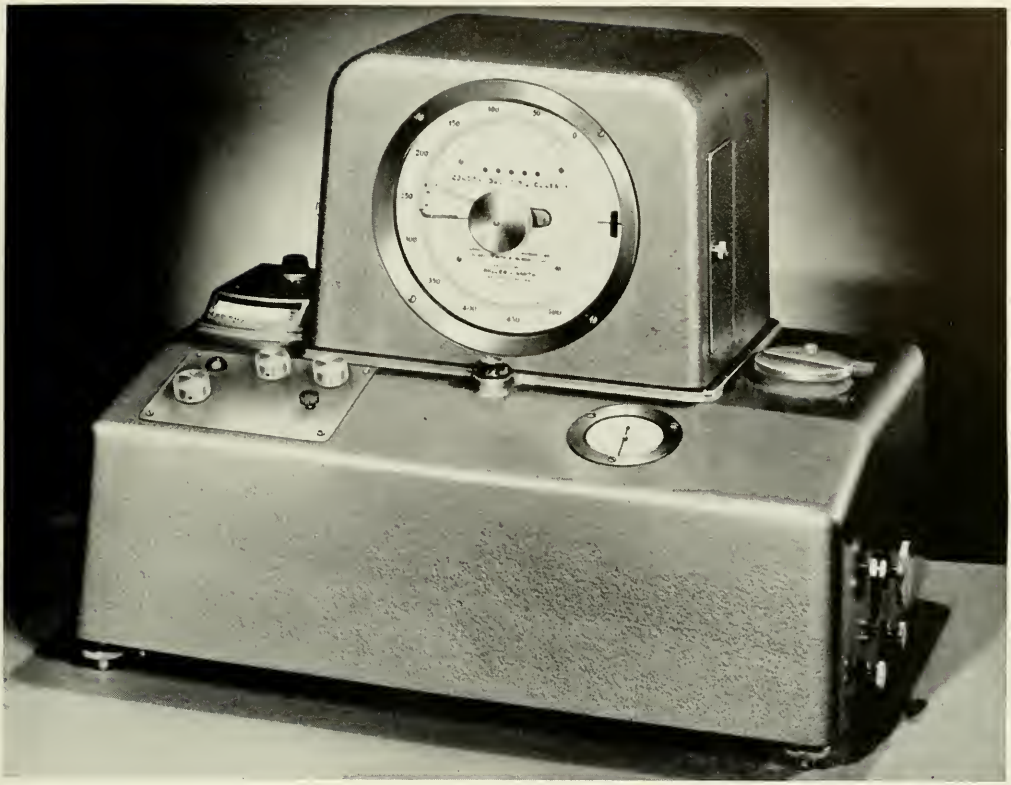

THE PERCENTAGE of hydrogen in liquid hydrocarbons can be determined by making two simultaneous measurements on the sample to give (1) density and (2) the absorption rate for beta rays. The weight percentage of hydrogen in the sample is computed from these measurements and a calibration curve. The new instrument shown here, a Standard Oil development, measures the beta ray absorption rate.

BETA RAY

used to speed hydrogen measurement

The problem: How to measure the percentage of hydrogen in organic compounds in a short time.

The established process was combustion. It took about four hours, and so discouraged the use of hydrogen determinations. But such analyses are increasingly important. Processes in the petroleum and chemical industries often involve hydrogenation or dehydrogenation. In addition, the percentage of hydrogen is an index to the performance of critical fuels such as those used in jet planes.

A rapid method for measuring hydrogen content would therefore be a great help in both research work and plant control. Standard Oil's Engineering Research Department, specialists in solving technical problems, took on this challenging assignment.

A new machine—a beta ray hydrogen analyzer—was invented and constructed. It gives results in five minutes, and is twice as accurate as the old combustion method. It is so easy to operate that a laboratory technician can use it.

Problems such as this are met continually in Standard Oil laboratories. They offer an opportunity for young men with training in chemistry and engineering to test their knowledge, skill and ingenuity.

Standard Oil Company

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STANDARD

ALPHA CHI SIGMA

by Lou Tichacek, Graduate

The professional fraternity for chemists and chemical engineers on the University of Illinois campus is Alpha Chi Sigma. The local chapter, Zeta, has been in existence 45 years and is now the largest of all collegiate chapters of Alpha Chi Sigma, having actives and pledges numbering about 80 and more than 1200 living alumni. In addition a majority of the faculty of the Department of Chemistry and Chemical Engineering are members of the fraternity, and their enthusiastic support has enabled this chapter to achieve its prominent position. Approximately 20 per cent of the present membership of Zeta are chemical engineers, both graduate and undergraduate students.

Although the social activities of the chapter are not minor, the fraternity is centered around professional interests. The present aims of the fraternity may still best be expressed by those of its founders:

1. To bind its members with a tie of true and lasting friendship;

2. To strive for the advancement of chemistry both as a science and as a profession;

3. To aid its members by every honorable means in the attainment of their ambitions as chemists throughout their mortal lives.

In keeping with these aims, Zeta chapter has traditionally sponsored activities of benefit to its members and to the chemical profession in general. A series of faculty lectures open to the public is arranged and presented at the chapter house during the school year. In addition a guest lecturer is brought to Urbana as the highlight of the annual Founder's Day banquet. At this same banquet the freshman in the chemical or chemical engineering curriculum who has attained the highest scholastic average is given an award by Zeta chapter in recognition of his academic excellence and promise in the profession. As an aid to safe practices in the Department of Chemistry and Chemical Engineering a standing safety committee is maintained by the chapter. Its duties include a semi-annual inspection of all laboratories, the sponsoring of a general laboratory clean-up day, and recommendations for correction of unsafe practices.

The national constitution of Alpha Chi Sigma restricts membership to men who are planning to make some branch of chemistry or a closely allied science their life work. A graduate student must be in good standing in the graduate school, and undergraduates must be of at least second semester sophomore standing and have a commendable average to be elected to membership. Since those qualified for membership can be in either academic or industrial work, the fraternity consists of both a collegiate and a professional branch. The collegiate branch has active chapters on 46 campuses with over 23,000 initiates, and the professional branch has 30 chapters located in centers of chemical industry throughout the country.

Alpha Chi Sigma had its origin at the University of Wisconsin in 1902 when nine undergraduates in chemistry organized it as the first professional fraternity in chemistry. Subsequently, chapters were chartered on other midwestern campuses, the sixth charter being granted to a group at the University of Illinois in 1908. The charter members of Zeta were eleven chemistry students who had joined together ". . . in order to promote the study of chemistry and to further fraternal relations between men of the profession . . ." The first activities of the chapter—meetings, lectures, smokers, and dances—were held at various places such as the Chemical Club Room, the YMCA, and the Elks Club. During the early years of Zeta its members were mostly undergraduates, and it belonged to the Inter-Fraternity Council. This chapter could, therefore, accept only members who belonged to none of the social fraternities and yet were students of chemistry. The activities of Zeta chapter became almost completely social, so much so that in 1921 a group of students in the departments of chemistry and ceramics laid plans for founding a new "truly professional" fraternity and called their organization Gamma Pi Upsilon. These two fraternities, with nearly the same written aims, coexisted on this campus for about ten years. In the early years of the depression Zeta, recognizing the disadvantages of trying to compete actively with strictly social fraternities while being able to pledge only members of the chemistry department, withdrew from the Inter-Fraternity Council and returned to the status of a professional fraternity. Their actual aims now being close to those of Gamma Pi Upsilon,

The Alpha Chi Sigma house at 606 W. Ohio.

A group picture of the Alpha Chi Sigma members.

a merger between the two organizations was approved by the membership involved. The new organization now took in members of social fraternities; it retained the name and charter of the national fraternity, Alpha Chi Sigma.

Despite the merger the advancement of the organization was hindered by the depression and growth was slow for the first few years. But after having kept residence in several temporary locations, the chapter moved to Nevada Street in 1934. This served as the home of Zeta until an expanding membership necessitated the acquisition of a larger chapter house in the summer of 1937, at which time the present house at 606 West Ohio Street was obtained.

This house comfortably fulfills the needs of the chapter, housing 43 of its members. Its library, started by the collection of periodicals and chemical texts in the early days of the fraternity, now contains a complete collection of the leading chemical journals as well as an extensive selection of textbooks in various scientific fields. The voluntary contributions of active members of the chapter and interested members of the academic staff have enabled this library to maintain a collection of chemical literature equal to that found in the libraries of many colleges. In a like manner, the interest of the members has enabled Zeta to build up a sizeable record library of both popular and classical music. The house also maintains the other recreational facilities common to most social fraternities. The present social program includes two formal dances as well as various informal events during the year.

Upon completing his academic work, a member of the collegiate branch may automatically enter the professional branch of the fraternity, and a great number of men do this each year. Thus members can maintain an active interest in the fraternity for as long as they wish; and the fact that such an interest exists is indicated by the continuing expansion of the professional branch into new regions as Alpha Chi Sigma members are brought in by the development of the chemical industry.

New Ultra-Sonic Burglar Alarm

A revolutionary new burglar alarm that capitalizes on the use of inaudible sound, traps intruders by their motion anywhere in a room or similar enclosed area. The system was invented by Mr. Samuel Bagno, vice president of the Alertronic Corporation, and is manufactured by the company.

Operating on the principle of magnetostrictive vibrations, the super-sensitive burglar alarm reports any disturbance of the ultra-sonic waves transmitted within an enclosed area.

The Alertonic system appears to be a simple device. Mounted on a wall, it looks like half a coffee can painted grey. From within the "can," which is really a diaphragm, ultra-sonic waves are generated. A similar "can" on an opposite wall receives the waves. Any motion that disturbs the waves causes the receiving "can" to transform the sound into electricity, feed it into an amplifier and then sound the alarm.

The sensitivity of the system is controlled just as you would the volume of your radio. It is usually set to detect a body as small as a child's, but can be tuned to such high sensitivity that a deep breath, a wink of an eye or wiggling finger will start it.

This sensitivity extends to the masses of air set in motion by fire. The alarm can even be set off simply by igniting a wad of newspaper. In Chicago, the ultra-sonic system detected a fire in an electro-plating plant that was put out before any serious damage was caused.

Ultra-sonic vibrations are generated from four nickel rods, thin as wooden matches and twice as long. The rods are riveted to the bottom of the "can" and wound with copper wire to set up a magnetic field. As the rods shrink and relax, 19,200 times per second, they vibrate the "can" or diaphragm which sends out waves into the surrounding area. 19,200 cycles is beyond the hearing range but not so high that the air would absorb the waves.

The principle of the new system, magnetstriction, has been known to science for many years, but until recently it was regarded as a laboratory curiosity. With the development of magnetostrictive oscillators, new fields of study were opened to science. A number of metals have this magnetostrictive property that utilizes an alternating magnetic field to get contraction and elongation. Few of them have it to any commercially valuable extent. Most widely used is nickel because it has a combination of several essential properties. This is the principle on which Mr. Bagno began his work in 1941. He discovered that a wave could be made to bounce off a wall and cast an inaudible echo from any moving object.

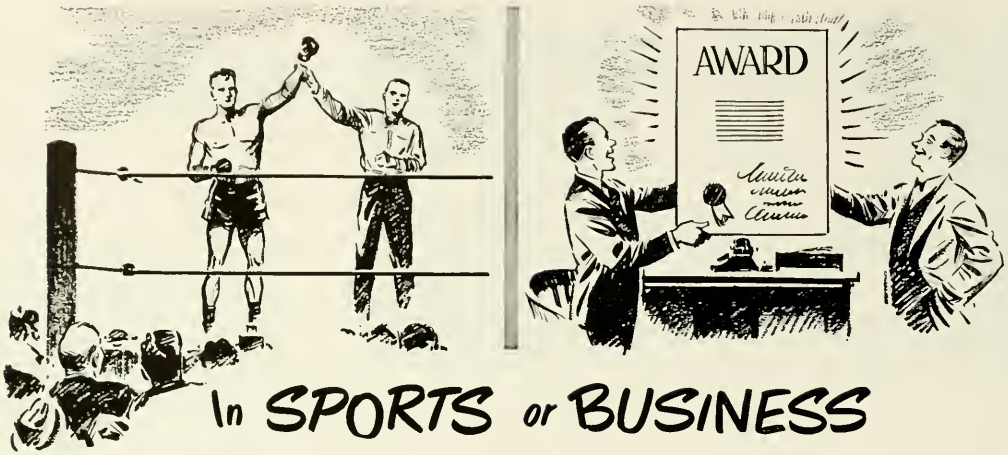
At first, Mr. Bagno's source of ultrasonic waves was a piezo-electric crystal. Later he decided to try nickel. He said that he changed to nickel instead of crystals "because of its more suitable low impedance value, both electrically and mechanically." In addition, nickel rods can be obtained in any desired length and diameter. The dimensions of the rods affect the vibrations. The rods are pure nickel and are wrapped with copper wire. At the ends, they are wrapped with a 50 nickel—50 iron alloy magnetic strip. The diaphragms that emit the vibrations contain two pairs of nickel rods in the transducers and one pair of nickel rods in the receiver.

The system not only detects burglars and fire but it has been found to kill mice and temporarily drive rats away. In a test by a Houston, Texas, school, six white mice caged near one of these devices were found dead in 30 minutes. In plants, mice were found with their skulls crushed, indicating they raced around in a frenzy until they hit something and died.

The Alertronic alarm system has received the approval of The Underwriters' Laboratories, who set standards for detection instruments.

NOTE

We wish to correct the erroneous byline given to "Rocket Development" in the November, 1953, issue. The article was written by Thomas L. Hermann, Aero. E., '56, not Tom Hoffman, Arch. E., '55.



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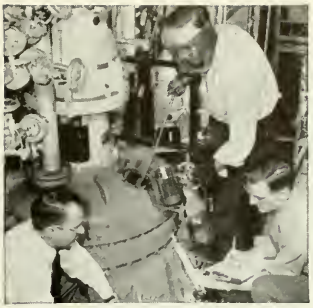
THE DU PONT DIGEST



Robert Thomson (*left*), B.S. in Ch.E., Univ. of Va. '50, **Dovid S. Rumsey** (*center*), M.S. in Ch., Univ. of Mich. '48, and **Rene M. LeClair** (*right*), M.S. in Ch. E., M.I.T. '51, test samples on an experimental batch unit.

Plant Development

Offers Training and Opportunity

John Purdom, M.S. in Ch.E., Ohio State '48 (*right*), confers with other engineers on the progress of a new plant.

A young chemical engineer recently had his first assignment in a *Plant Development* group at Du Pont. He was part of a team assigned to improve recovery of adipic acid, a nylon intermediate, from plant-waste streams.

First, he made a literature survey for possible leads. Three recovery methods came under consideration: *solvent extraction*, *crystallization*, and a combination *distillation-crystallization* process. He helped to set up a laboratory program to compare and evaluate them.

Preliminary results were somewhat inconclusive. It was decided to go ahead with semi-works tests, while an organic chemist completed the laboratory work.

Next, the young chemical engineer joined forces with a mechanical engineer to design a semi-works plant to evaluate each method. In this plant, all vital points were checked and rechecked: materials of construction, steam and water requirements, heat-transfer coefficients, yields, product quality, and pollution problems.

The semi-works data revealed that the *distillation-crystallization* process was the most economical, and also gave the best product quality. Usually, the next step would be construction and operation of a pilot plant. But this time, engineers from the *Production Division* arranged for a limited-scale plant test, using a spare batch still and a crystallizer on a part-time basis. Two months of testing confirmed the previous data—the new *distillation-crystallization* process recovered adipic acid efficiently, and would reduce costs considerably. The plant is now using this process successfully.

That's how one young chemical engineer started his career in a typical Du Pont *Plant Development* group. The job of such groups is to make processes and equipment more efficient, to adapt products to new uses, and to improve product quality.

Plant Development work not only offers opportunity in itself but valuable training for other fields.

ASK FOR "Chemical Engineers at DuPont." This new illustrated booklet describes initial assignments, training, and paths of promotion. Just send a post card to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware. Also available: "Du Pont Company and the College Graduate" and "Mechanical Engineers at Du Pont."

DU PONT
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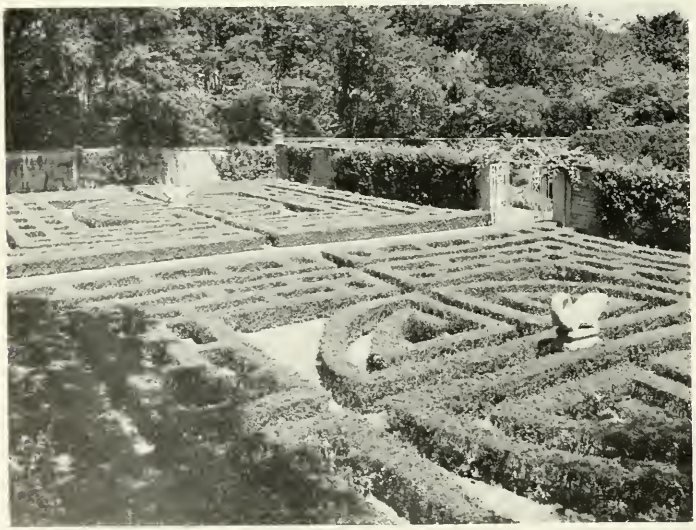
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Watch "Cavalcade of America," on Television

Robert All

The Reception Hall of Allerton House. Much of the furnishings in this hall, as well as the rest of the house, are imported articles. Allerton House is now used by the University for banquets and conferences and many of the guests of the University stay in the house during their visit.

From the balcony of this tower or
the park. The statue standing in si
from the Orient.



The Hedge Garden. This is only one of the many beautiful gardens in the park. A part of the farmland is used in connection with agricultural research.

Photos

The University of Illi

rton Park

view several of the gardens in
door of the tower was imported

sy of
blic Relations Office

Allerton House, as viewed from across the fish pond. Robert Allerton Park was given to the University of Illinois from the estate of Robert Allerton. It comprises several hundred acres of gardens and woods immediately around the house, along with several thousand acres of farmland and woodland in the vicinity.

The Garden of the Dogs. On each pedestal in the gorden stands a statue of a Chinese dog. All twenty-four of the statues were imported from the Orient.

logical way

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TRIANGLE, A FRATERNITY

of

Architects

and

Engineers

by Bob Haven,
Chem. E., 1955

This is the final in a series of three articles on engineering social fraternities in this issue of the Technograph.

To me, the words above mean more than just the place where I live while on campus; more than just a place to study, eat, and sleep. They symbolize the experiences encountered in a brotherhood of men—all working toward a common goal which has two phases: first, by getting a working knowledge of the principles involved, to get a degree in some branch of engineering or architecture; and second to live college life to its fullest through participation in extracurricular activities. The object of this article is to give you a good picture of how Triangle functions and how the men of Triangle fulfill the goal mentioned above.

At this point, it would be a good idea to outline a few general advantages of living in a fraternity.

First, living in a group of this type gives one a chance to pick up social refinements which might not be available elsewhere. This is a category in which many of us engineers are sadly lacking.

Second, one makes permanent friendships that are not only pleasant, but may be helpful later when trying to get a job (if we ever get out of the military!)

Some men may be leaving home for the first time when coming to campus. The feeling of belonging created by a fraternity is accompanied by a feeling of being wanted—not an unwelcome thing when one is struggling through four or five years of technical training at a university.

One condition peculiar to fraternities and similar organizations is the dependency of everyone in the group on every other person. This dependency, along with a constant contact with others' ideas affecting the whole group, requires and develops four traits which are always valuable: responsibility; cooperation; open-minded consideration of the ideas of others; and confident proficiency in speech and actions.

The advantages that I have mentioned in the few paragraphs above could apply to any fraternity. However, in Triangle, we believe we have one additional and very important advantage. Due to the fact that we are all engaged in the same general field of endeavor, we all have to study about the same amount and at about the same time. Because of this common need, when it is time to study, an atmosphere conducive to concentrated application is present; and then when its time to party, we all party together. We aren't hindered by stereotyped individual personalities, either. Contrary to the beliefs of some people, engineers and architects, aside from their vocations, can have as varied interests and per-

Triangle Fraternity House at 112 East Daniel. (Photo by Felix Studio)

Triangle's alums "came home" in 1952 to this decoration which took 2nd prize in the Homecoming House Decorations Contest. (Photo by Felix Studio)

sonalities as any two people. We believe that because we do things as a group, and yet are stimulated by individual personalities, we have a much more closely knit organization than those of other fraternities.

Triangle Fraternity was founded here at the U. of I. in the Fall of 1906 by sixteen civil engineering students. Several of the founders are still active in the national organization of the fraternity. At first, the fraternity admitted only civil engineering students, but later the national constitution was altered to admit men in any branch of engineering and finally to admit architects.

Since its founding, Triangle has established chapters in most of the Big Ten Schools and other central U. S. colleges and universities. The chapters had their beginnings in such organizations as the Transit Clubs of Purdue and Ohio State, the Qual-L Club of the University of Michigan, The Grubstaker's Club of the Missouri School of Mines and Metallurgy, and many other similar groups of engineering students.

Several traditions, some local, and others national, have naturally developed through the years. One of these traditions, started by one of the earlier chapters, is the presentation of "The Triangle Rattle" to each newly installed "baby" chapter. The name of each chapter has been placed on the rattle, with the names of new chapters to be added as they are organized.

The Illinois and Ohio State Chapters of Triangle have a traveling trophy, the retention of which depends upon who wins the Ohio State-Illinois football game. Did we see red, when, after the Illinois victory of the past season, we received the trophy in the mail—collect! A more general tradition is the annual Founders' Day Celebration held at each of the chapters.

As far as insignae are concerned, the active pin, the pledge pin, the colors, and the crest are the most important. Roughly, a description of the active pin: The active pin or badge is in the shape of a triangle. Enclosed by the triangle is a "T", and, superimposed on the triangle is a very traditional tool of engineers, the transit. The pledge pin is also triangular with a small "T" in the center. Official colors of old rose and gray were adopted in 1913. The crest is too complicated to describe here.

Now for a few words about the organization of Triangle on a national scale. The legislative body is the National Convention, including national officers and delegates from each chapter and alumni organization. The convention also acts as a final tribunal in judicial matters. The National Council, composed of the national officers, acts as the executive body of the fraternity.

Locally, each chapter has its own officers, as does its component alumni and active organizations. These officers administer their respective affairs under the national and chapter constitutions.

Without a high calibre of personnel, any organization cannot function. The following quotation from the "Triangle Pledge Manual" illustrates the emphasis placed on personnel:

"Because fraternity means brotherhood, involving individuals, great stress is placed on personnel matters. Careful attention is paid to selection through "rushing", development and training through assistance and service, and final attainment of good fellowship and accomplishment. By seeking a high standard in the individual, group prestige rises proportionately."

Rushing at the Illinois Chapter of Triangle is carried on informally rather than going into formal rushing. We believe that we can better acquaint ourselves with the men, as well as let them become better acquainted with us.

Recognition of outstanding achievement is not wanting at Triangle. The Triangle Service Key is presented once a year to some member for pre-eminent work in developing the national organization of the Fraternity. To the local active organization, which in the opinion

"A bunch of crooks"—our 1953 Spring Carnival show, done in conjunction with 4-H House. (Photo by Illini Studio)

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The Purdue chapter purchased three fire engines, then sold two of them to pay for the third. A bunch of the Purdue boys drove down on it to see us. (Photo by the Champaign-Urbana Courier)

of the National Council, has done the most during the preceeding year to foster friendly relations with their alumni, is presented the Alumni Relations Plaque. A trophy to the chapter boasting the highest scholarship record for the past year is presented each year, as is a plaque for the greatest improvement in scholarship. Every year on Founders Day here at the Illinois Chapter, the E. E. Bauer Award and the Pledge Trophy are presented. They go, respectively, to the outstanding graduating active, and the outstanding pledge of the past year.

Contact with Triangle does not cease upon graduation. Another quotation from the "Triangle Pledge Manual,"

"The satisfactions of brotherhood continue to expand throughout lifetime. Triangle has an incalculable professional value to its members, since it is certain that one will find at least one brother (often in key positions) in practically all technical or scientific organizations and firms.

Triangle associations are another source of enjoyment subsequent to undergraduate days. These groups are composed of alumni members from different chapters who reside in a particular city or area. They meet regularly for social and professional programs."

After graduation all alumni receive the official magazine, The Triangle Review, containing current news of the Fraternity and its members. Many alumni also subscribe to the news letters of the individual chapters. Both of these publications do a lot toward preserving and strengthening the fraternal spirit.

A mention of finances now seems to be in order. Each initiate pays an initiation fee, part of which is used to provide him with a life subscription to the Triangle Review, and part to defray the expenses of the national organization. House upkeep and board is taken care of thereafter by a monthly housebill. The total cost, per semester, included social assessments, is about $340. On the national level, a Permanent Fund, managed by a Board of Trustees, has been organized. The Permanent Fund is composed of a percentage of the initiation fees of new members; and voluntary contributions of members. The interest earnings of the Fund are used to meet the obligations of furnishing, the Triangle Review to life subscribers, and for loans to Triangle juniors and seniors who need financial assitance in order to complete their college education.

I said something several hundred words ago about living college life to its fullest. This can include a lot of things, but some of these might be social functions, sports, and participation in the activities of other groups around campus. The social calendar of Triangle is not quite as extensive as those of some fraternities, but we have a lot of fun. Annual big events include the Christmas Dance and the Spring Formal. We usually manage to have a number of informal sweater dances during the football season and a few picnics in the Spring—and of course, unofficially there is always T G I F.

As far as sports are concerned, we always enter as many intramural sports as the size of the chapter will allow.

Participation in the activities of other groups includes membership in the Interfraternity Council and in Star and Scroll Fraternity. Of course, individual participation in activities is encouraged, but it is not required. A couple of men from the House will usually be found on the Engineering Council, and we usually participate extensively in the annual Engineering Open House.

Well, there it is. I've had great subject material, but I may have included too much. Anyway, knowing that if I have given you a straightforward picture of our fraternity, there is no need to worry about your opinion of Triangle, as I am confident that this picture will win friends for itself.

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The Central District Filtration Plant in Chicago

by Gerald Wheeler, C.E. '56

Have you ever paused on a hot day to drink a glass of *cool, clear* water? If you live in Chicago north of 39th Street, the chances are that you have not. The reason is that Chicago, as a whole, does not have filtered water. During stormy months of the year, Chicagoans have been obliged to drink water not only muddy and foul tasting, but also ordorous. At one time the water had a threshold odor of 40—which means that it is necessary to mix 39 parts of clear water with one part of raw water to remove the smell.

GERALD WHEELER

Gerald has been a member of the Technograph staff for two semesters at Navy Pier, during which time he has held the position of business manager. His curriculum is Civil Engineering from which he will graduate in 1956.

For many years the problem of supplying Chicago with an adequate supply of clear water has gone unsolved. Imagine what a great engineering feat has been accomplished in constructing the South Side Filtration plant! It supplies clear, filtered water to over one-and-a-half million people. More than 500 M.G.D. (million gallons daily) are processed and used by Chicagoans. The proposed Central District Filtration plant will provide filtered water to approximately 3,000,000 people residing in the northern two-thirds of Chicago and adjacent suburbs. The plant will have a rated capacity of 960 M.G.D.

The Central District Filtration Plant will occupy 61 acres of made land 400 feet north of Navy Pier and some 500 to 1500 feet east of Lake Shore Drive. (see plan) It will be the largest (and most expensive) filtration plant in the world. The original estimated cost of the plant originally was $61,700,000, a more recent estimate being approximately $85,000,000.

There are several reasons why the lake front site was preferred over any of the other sites studied. The two most important reasons were the fact that a single plant at this location would have a total annual operating cost of $140,000 less than separate plants for the North and Central district, and it would have two sources of supply—the existing tunnels from the Dever and Carter-Harrison cribs, and a lake-port intake at the front of the plant itself.

Water filtration is simply a process by which, after removal of heavy sludge water is let stand in great settling tanks and then filtered through layers of rock and sand of increasing fineness until it merges clear and almost chemically pure. Of course, when you consider the size of Chicago and the immense consumption of water that occurs daily, this simple process becomes much more complex. For instance, the South Side Filtration Plant draws its raw-water supply from either the Edward F. Dunne Crib or via a direct intake within the breakwater off the shoreline of the plant. Water is sucked from intake basins by eight pumps (with a total capacity of 840 M.G.D.) located in the low-lift pumping station. These raise the water from 20 to 25 feet to the two raw-water conduits—one above the other. From the conduits the water passes into mixing basins where it is thoroughly mixed, and then processed by chemicals both to purify it and to speed coagulation of the silt. As the sediment settles, scrapers take away the sludge, which is pumped through two lines out into the lake on the southeast. After passing through 501 feet of settling basins un-

Schematic diagram of the central district filtration plant.

East wall of cofferdam.

derground, the water arrives at the Filter Building (which contain 50 filters of gravel and sand, 46½″ in depth, ranging from gravel in diameters of 3½″ to ⅛″ to sand in diameters of 0.62 mm. to 0.70 mm.). From the filter basins the water passes into the Filtered Water Reservoir from which the South Districts supply is drawn. The Central District Filtration Plant will be similar in operation to the South District, the main difference being in size. The physical layout is better, the pumps are longer, and the capacity will be three times as great.

From a structural engineer's standpoint, the Central District Filtration Plant offers a chance for new construction ideas to be put into practice. The foundations consist of concrete piers and walls, direct on bedrock, anchored to rocks with steel dowels to protect flotation of the plant when empty. The bulkhead surrounding the plant is a rock-filled dam, composed of clay-core fill and a steel-sheet-piling cut-off wall, driven to rock. The top of the bulkhead is capped with heavy stone (see picture) to protect it against heavy waves. The first steel sheet piling was driven on February 21, 1951. (see picture)

Before such work could be started however, extensive investigations on the foundation conditions existing at the plant site and along the lines of the connecting tunnels were made. These investigations included a large number of borings through the underlying clay at the site to determine the proper foundation treatment for the cofferdam and the plant structures. Also, a supersonic survey was conducted over a large area to determine the elevation of the underlying rock formation.

For construction of substructure and intake wells, low-lift pumping station, raw-water conduits, mixing basins and filtered water reservoirs, reinforced concrete will be used extensively. The reservoir (see diagram) will have a total capacity of 67 million gallons, being 960 ft. in length, with an avearge width of 480 feet, and having a 20-foot water depth. The roof will be of flat slab construction with approximately 800 columns on 23-foot centers in each direction.

Reinforced concrete will also be used for the framework of the chemical building, but structural steel framework selected for the superstructures of the low-lift pumping station, filter building, Administration Building, and control laboratory.

The low-lift pumping station will be built on a reinforced concrete substructure, the upper portions of the building framed in structural steel and the pump room spanned by a series of rigid steel frames.

Only one contract has been let for the construction of the plant so far. This was for the cofferdam which will permit the de-watering of 61 acres within which the major structures of the plant will be built. The low bid on this work was $6,597,510, and approximately $2,000,000 worth of work has been done on this contract to date. The reason for only the one contract and also for the work stoppage at the present time is that a number of property owners in the area of Lake Shore Drive filed a complaint in Circuit Court against the city regarding the construction of the plant. The court recently (Aug. 28, 1953) rendered an opinion in favor of the complainants. The city is now appealing to the State Supreme Court for a reversal of this decision.

The argument of the property owners was that the construction of the plant would not only detract from the beauty of the lake front, but it would also decrease the value of property near the site. They also believed that the plant would interfere with future harbor development.

As far as beauty is concerned, (see aerial photograph) in a report by the Chicago Department of Public Works (March, 1951) it was stated that:

"This filtration park should be the most beautiful addition ever made to

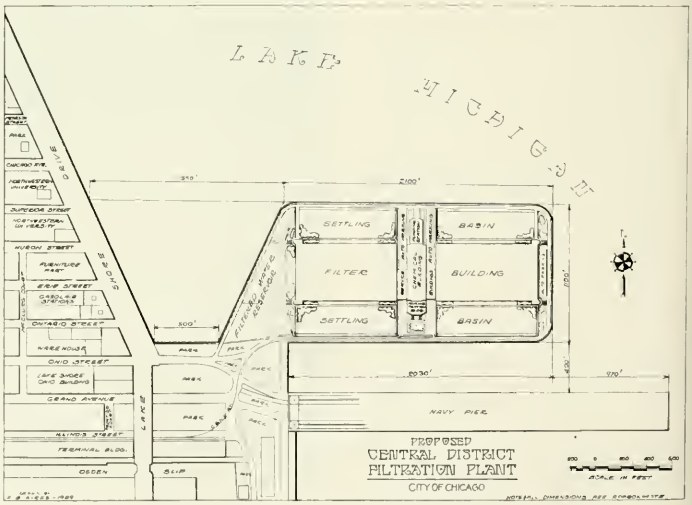


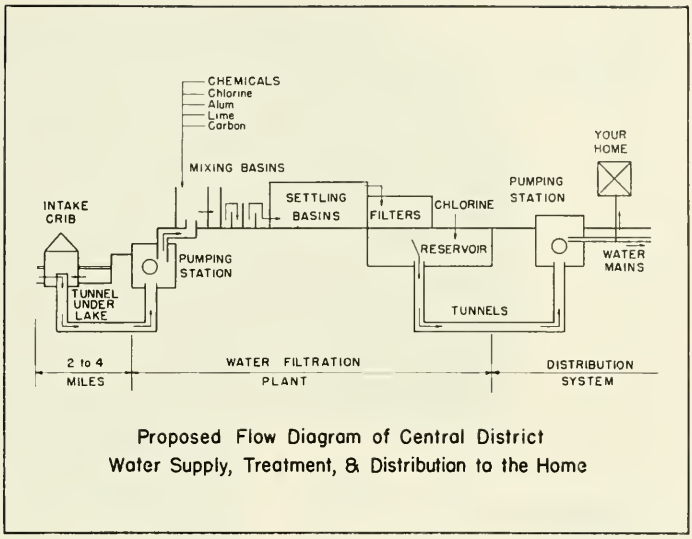
Diagram showing layout of central district filtration plant.

Chicago's lake front. The opportunity to view the park from across the water and the large amount of area available for landscaping makes this possible. There is only one building of any height and this building will have a ground floor area of only 110′ x 220′ or slightly more than one-half acre. . . . The filter buildings will be about 20 feet high. Except on the east side there are wide expanses of lawn between the buildings and the lake front. The park will serve as an effective shield and barrier against industrial encroachment from the south. . . . Landscaping will include trees, lawns, terraces, shrubs, vines and flowers."

According to a second report, made by Mr. George S. Salter, engineer in charge of Filtration Design, " . . . the Filtration Plant will provide a 400-foot ship anchorage between the south wall of the cofferdam (see plan) and the north side of Navy Pier, and thus make usable the north side of Navy Pier for shipping purposes. Also, the city proposes to develop the south cofferdam wall for dock purposes. This dock will permit the anchorage of two 700-foot ships in the sheltered area between the plant and Navy Pier, and the dock can also be used for ships and barges bringing supplies for the operation of the plant."

Chicagoans have everything to gain and nothing to lose by the construction of this plant. No funds will be obtained from taxation. Construction of the plant is being financed by issuance of Waterworks Certificates and by monies received from water revenues. (As of today, Chicago pays less for water than most other cities.) All construction and operating costs of the Chicago Water System are financed from revenues derived from the operation of the system. Part of the expense of preparing plans and specifications for the filtration plant project were obtained from the state of Illinois, as a grant, and some monies have been obtained from the Federal government.

If the Supreme Court of Illinois renders a decision in favor of the average citizen rather than of a few wealthy landowners, Chicago may soon have the best and largest filtration plant in the world.



Proposed Flow Diagram of Central District Water Supply, Treatment, & Distribution to the Home

First piling for cofferdam being driven at south west corner of plant.

ACKNOWLEDGEMENTS

Mr. George S. Salter, engineer in charge of Filtration Design for the Central District Filtration Plant.

Progressive Architecture, March, 1950.

The Chicago Department of Public Works.

Mr. J. G. Chaderton, Assistant Professor of Civil Engineering, University of Illinois, Chicago, Illinois.

F. W. Trezise, Dean of Engineering, University of Illinois, Chicago, Illinois.

Typical scow load of "B" stone for cofferdam.

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Section of 114-year-old cast iron gas main still in service in Baltimore, Md.

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Another page for **YOUR BEARING NOTEBOOK**

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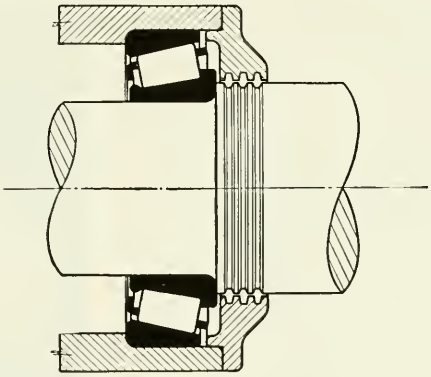

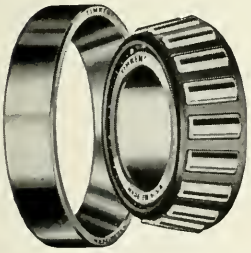

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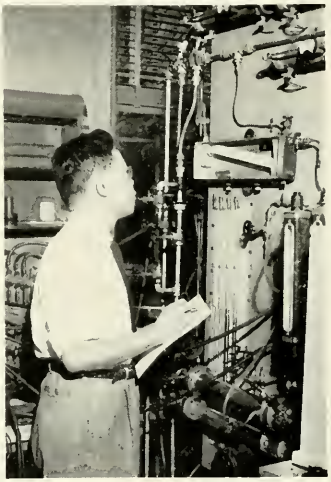
AEROSOL RESEARCH

by Warren Conner, M.E. '56

"It's the dusts quantity, when illuminated by a powerful and strongly concentrated beam, that sometimes appears enormous. One recoils from the idea of placing the mouth at the intensely illuminated focus and inhaling the swimming dust there. Nor is the disgust removed by the reflection that at a distance from the focus, though we do not see the dust, we are breathing precisely the same air."—John Tyndall.

The air about us contains billions of small particles of every description and diverse composition. Many of these particles settle out, while multitudes more are destined to float aimlessly, but ceaselessly, for lengthy intervals of time. Many of these particles arise from natural processes, such as dusts stirred from dry areas by the wind, evaporation of sprays from the sea, and photosynthesis from vapors released from trees and plants.

The size of these particles is extremely small. They may be as large as a raindrop and yet, by air action, remain afloat for a duration of time. The extremely small particles that float about are called aerosol particles and are of the order of ten microns in magnitude or smaller. To orient the size of an aerosol particle, let us examine the size of a micron. A human hair is in the order of twenty-five microns, while small bacteria measure from one to ten microns in size. The mass of an aerosol particle is extremely small also. They average about 10^{-16} grams. It is aerosols that we see in a fog, a haze, and in smoke. A small volume may contain fabulous numbers of these particles. Even in the country where the air is relatively free from smoke and industrial dusts, the concentration of these particles in the air that are detectable only by a microscope exceeds a million per cubic foot. If the range is extended by the ultramicroscope to include smaller aerosols, the count is increased as much as twenty-fold. In industrial areas, where smokes and fumes are discharged, the concentration may be greater by another order of magniture. A simple estimate based on the known screening effect of oil smoke at the optimum droplet size of about 0.5 micron diameter shows that the concentration of



Dr. C. Y. Chen in his laboratory at his diffusion filtration apparatus.

particles in a blue haze with a visibility of three miles is about forty-five million per cubic foot. For intense smog of low visibility, such as occurs in Los Angeles, the concentration is often ten times greater. These high particle counts and effective light scattering by small aerosol particles are very different from ordinary fog in which the droplets range from 5 to 50 microns diameter and the count is 20,000 to 100,000 per cubic foot.

Atmospheric aerosols may be from approximately .05 to 10 microns in diameter. There is thought to be no minimum diameter for these particles, but man's ingenuity and senses limits him to be certain about the functions and activities of the smallest aerosols.

Let us examine the air that we breathe. Man breathes, under normal activity, about one-half cubic foot of air per minute. Suppose, on the average, the diameter of the particles he inhales is 0.5 micron, and the density is that of water. In a lifetime of seventy years in air containing five million particles per cubic foot, he would inhale about six grams of particles, and only a small portion of these would be retained in the respiratory system. This illustrates one important feature of atmospheric aerosols, namely, the very low mass concentration.

The forces which act on aerosols, of which there are many, are complex and difficult to understand unless one considers the various forces acting on an isolated aerosol particle. Then the forces can be explained by classical mechanics. A list of the individual forces which may act on aerosol particles are given as such:

Gravity	$F_g = M_z$
Fluid Resistance	$F_u = -(1/Z)(u-v)$
Electrostatic	$F_e = 9_p E$
Thermal	$F_t = -K_1 gRAd\ T$

Other forces may seem to influence the motion of aerosols, but they are either negligible or their significance is doubtful. In any event, to be considered seriously, they should be of the order of magnitude of the gravity force.

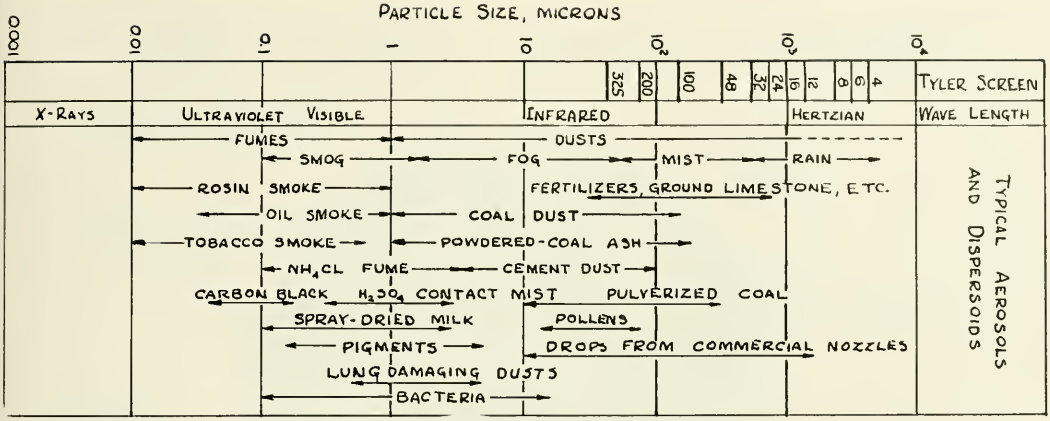
It has been suggested that the electrical force is by far the most influencing force determining whether the aerosol particles will settle out. It may be possible for the particle to be attracted or repelled by an electrostatic force greater than ten times that of gravity.

The University of Illinois chemical engineering department is studying the formation and behavior of aerosols. The research being conducted is largely fundamental, but applications relating to aerosols, their supply, control, and deposition are readily formed through this extensive research.

The aerosol group under the direction of Dr. H. F. Johnstone, is so divided up that each individual working in the group studies the action of one particular force on aerosols.

Mr. S. K. Friedlander, who is conducting research on the deposition of aerosols by turbulent forces, studies aerosol particles with the aid of a microscope to measure the amount of particles deposited from a moving aerosol-gas mixture. It appears that the particles deposite more rapidly as turbulence increases. Very few particles are removed when the gas-aerosol flow is streamline according to Mr. Friedlander.

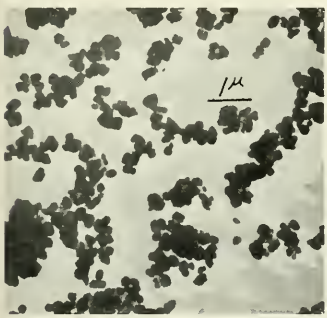
Mr. Saxton has studied the effects



Characteristic aerosol sizes and comparisons.

of thermal forces, while Mr. G. R. Gillespie observed the formation of such hydroscopic aerosols as H_2SO_4. This particular study is of interest to the sulfuric acid industry as H_2SO_4 mists pose a problem to the acid manufacture.

Dr. C. Y. Chen is working a contract with the Army Chemical Corps which is particularly interested in the



Titanium Dioxide aerosol particles.

improvement of gas masks. Dr. Chen is studying diffusion, a mechanism which is peculiar to relatively small aerosol particles.

Dr. James Wong conducted research on the inertial forces affecting aerosol removal in filtration; his studies have been concerned with aerosols composed of larger particles.

Mr. Kraemer has been conducting research on the electrostatic forces affecting aerosols. He passed a gas-aerosol mixture (with the aerosol particles all charged with like charges) around a sphere which was charged oppositely. Mr. Kraemer theorized and predicted the results of this experiment with fairly high accuracy. Mr. H. Suchan is now studying how to apply Mr. Kraemer's theory to specific problems.

The Atomic Energy Commission is sponsoring some of these projects as they are interested in how to control radioactive aerosols that arise from the manufacture of many radioactive products.

All the research being carried on at the University of Illinoi sis building the basic foundation for this relatively new science. The science of aerosols is complicated and its uses are great in number. The infant science of rainmaking is being furthered by this science. Air pollution is a grave problem especially when it is considered with atomic processes which yield deadly radioactive aerosols; engineers and scientists will now be able to lick this problem along with fog and smog dispersion. As in any new science, the basic laws must be established, and that is what is being done today in Aerosol Research.

Some information for this article was taken from a paper written by W. E. Ranz and H. F. Johnstone.

HISTORY OF A JOKE

1 minute—Freshman thinks of a joke and tells it one night to his girl friend on the steps of a residence hall.

1 day—Joke circulates through girl friend's sorority and is accidentally overheard by senior in engineering.

1 week—Engineer sends joke to Technograph (this is a joke itself) claiming originality. Editor of Technograph happens to desperately need five more lines of copy, takes a chance on getting expelled from school by using it.

1 month—Joke appears in back part of magazine among ads. The Dean sees joke and chastises editor.

1 year—Joke circulates through every engineering college magazine from Louisiana to Minnesota, New York to California.

2 years—Gag writer for a radio program finds local college magazine on a bus and sees jokes therein. Joke is heard on next week's program. Gag writer loses union card.

3 years—*Readers Digest* prints joke from radio program.

4 years—College professor finally gets around to reading the issue of Reader's Digest and laughs heartily at joke.

5 to 30 years—College professor uses joke to begin first lecture at start of each term.

* * *

Mother: "What took you so long to say goodnight to that fellow?"

Daughter: "But, mother, if a boy takes you to a movie, the least you can do is kiss him goodnight."

Mother: "But I thought you went to El Morocco."

Daughter: "Yes, mother."

* * *

A despondent old gentleman emerged from his club and climbed into his limousine.

"Where to, sir?" asked the chauffeur.

"Drive off a cliff, James, I'm committing suicide."

* * *

Ole walked into the saloon and asked for a shot of squirrel whiskey.

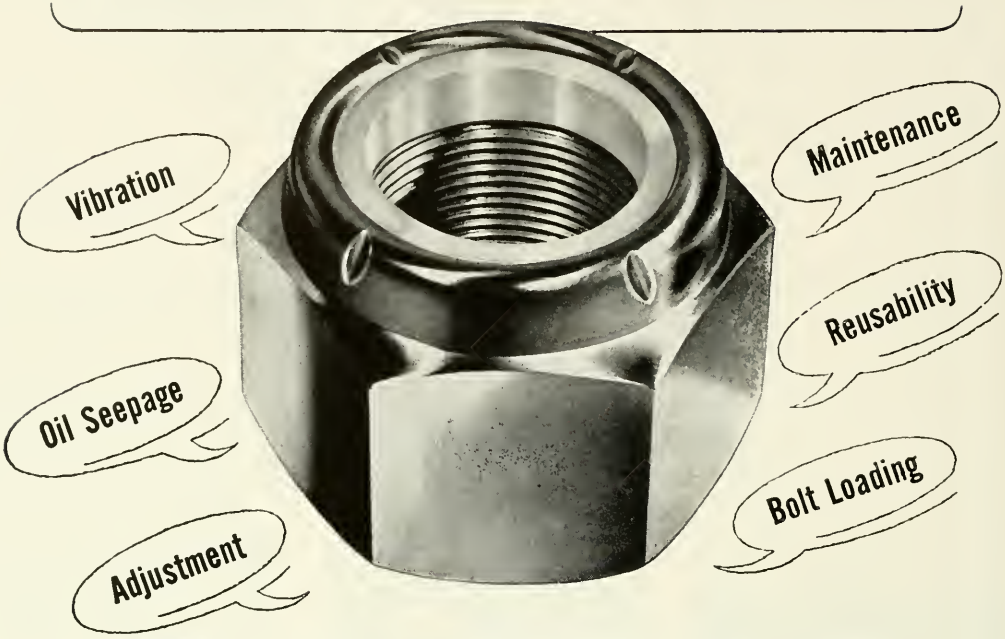
"Sorry," said the bartender, "but all we have is Old Crow."

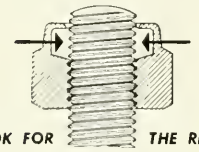
"I don't want to fly—I yust want yump around a little."

* * *

Then there's the bachelor who got thrown out of his apartment when the landlady heard him drop his shoes on the floor twice.

Whenever fastening problems arise...





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The University of Illinois . . .

ABBOTT POWER PLANT

by Charles Runyan, E.E. '57

The University of Illinois has completed a building program to enlarge and improve its facilities for handling its growing student enrollment. To supply steam and power to the new buildings, research laboratories and other facilities, the University's power plant has expanded by adding two turbine generator units and a fourth steam generating unit.

The Abbott power plant was built in 1940 at the west end of the campus, and was named after W. L. Abbott, who had been chief operating engineer of Commonwealth Edison Co., for 50 years, and had served for 18 years on the University's board of trustees, 14 of them as its president.

The power plant when first built contained 80,000 pound-per-hour horizontal cross-drum straight tube boilers, generating steam at 325 pounds-per-square inch, 650 degrees total temperature for two 3000 kilowatt steam turbine generator units, which supplied extraction and exhaust steam at pressures varying between 10 and 70 lb. sq. in. from summer to peak winter heating load. Live steam is sent directly from the boilers through pressure reducing and desuperheating stations into the steam distribution mains at 150 lb. sq. in. 450 degrees F to serve process requirements on the campus. The generators supplied electric power at 4160 volts to the electrical distribution system. The building was designed to house three steam generator units and three turbine generator units.

Early in 1945 the plant was lacking electrical generating and steam capacity,

CHARLES RUNYAN

Charles is a freshman in Electrical Engineering. He spent four years as a technical instructor while serving in the Air Force before coming to the University of Illinois. He is a graduate of Danville High School.

so during the '45-'47 biennium, funds for an additional boiler and generator was requested. In 1949 a fourth turbine generator was installed, and the turbine room was extended to accommodate it. The load has continued to grow, and plans are being made to install a fifth turbine.

A view of the plant showing the 200 ft. chimneys. The plant is one of the most modern in Illinois. It is equipped with dust collectors which nearly eliminate the soot nuisance. Three men per shift can operate and maintain the plant.

Abbott Plant Today

The plant now contains four 80,000 lb. /hr. boilers and four turbine generator units of 3000 kw capacity. All boilers are coal fed. Two of the boilers are equipped to use oil in case of an emergency. The coal is one and one-fourth in., washed and dryed central Illinois screenings obtained from the Vermilion county-Danville region. The coal is hauled to the plant in 50 ton railroad cars. It is then dumped into hoppers which feeds the coal onto an apron conveyor. This brings the coal to a bucket conveyor which raises the coal to almost the top of the plant building where scraper conveyors carry it to the coal bunkers. There is one bunker for each of the four boilers. Each of the bunkers holds 100 tons of coal. From there the coal feeds by gravity through a pair of scales which automatically weighs and records all coal delivered to each boiler. From the scales, the coal is dumped into a spreader shoot which spreads coal evenly across a slow moving chain grate in six inch layers. The chain grate moves slowly through the furnace boilers where it is burned. It then falls off the grate into ash hoppers which can hold about eight hours coal burning. The hoppers are then emptied by lifts and placed outside. Most of the ashes are consumed by the highway department.

Campus Heating and Electricity

The plant supplies electricity for 178 major and minor buildings on the campus, and supplies heat for 78 major buildings. In the winter time most of the steam passes through the turbines and drives the generators while the exhaust is used to heat the buildings. The

The design engineer trained in welded steel construction is best able to meet industry's need for low cost manufacture because

WELDED DESIGNS CUT COSTS 50%

BY using steel instead of cast iron, design engineers today make their products more efficient . . . *many times at half the cost.* Product designs are stronger, more rigid, take less material to build.

Too little attention is usually devoted to simplification of product designs to eliminate costly manufacturing manhours once a basic design is established. Where designers reappraise product details for welded steel construction, production costs are being cut an average of 50% compared with manufacture using castings.

Manufacturing operations are simplified with welded steel design. Rejections due to inferior metal are eliminated. Less machining and finishing are required. Finished machines are streamlined, more modern in appearance.

In the example below, an economy-minded design engineer lowered manufacturing cost on a machine arm and cut weight of the arm.

Before conversion to steel, the machine arm required 182 pounds of gray iron and cost $38.25 to cast and machine. Welded steel design weighs only 86.8 pounds . . . costs $20.06.

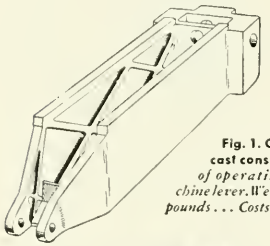

Fig. 1. Original cast construction *of operating machine lever. Weighs 182 pounds . . . Costs $38.25.*

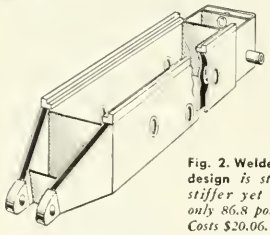

Fig. 2. Welded steel design *is stronger, stiffer yet weighs only 86.8 pounds... Costs $20.06.*

DESIGN DATA *for welded construction is available to engineering students in the form of bulletins and handbooks. Write*

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THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

Looking inside of the modern Abbott Power plant, University of Illinois. The plant is now equipped with four turbine generating units (shown in picture) rated at 3000 kilovolts. The original control panel was only one third the present size.

steam is sent out through distribution system which consists of three and one-half miles of underground concrete tunnels and 14 miles of piping, which if laid end to end would reach from here to Rantoul. The steam is sent out at 50 lb. sq. in. on a cold day and 10 lb. sq. in. on a mild spring day. These underground tunnels are approximately six feet wide and eight feet deep. In the early mornings around 5 o'clock when very little electricity is being used the exhaust steam is not sufficient to heat the buildings. The steam is then fed directly from the boilers into the heating main and by means of a pressure reducing system the 325 lb. pressure is produced to the 10 lb. or 50 lb. pressure that is required. During an average day the boilers burn 150 ton of coal and as much as 250 ton on cold days.

Details on the Boilers

The boilers are shaped with a sloping fornt arch, a moderate rear arch and a provision for as much as 10% of total preheated combustion air to be introduced through the front arch as overfire air. This overfire air is drawn from the preheated air duct by a separate air fan, and is discharged to an air duct feeding the overfire air nozzles. The stoker windbox is divided and dampened for close control of combustion air supply under the stoker as desired by the operator.

The boiler is equipped with both economizer and air preheater, and has a dust collector installed following the boiler outlet and ahead of the economizer, air heater and induced draft fan to minimize fly ash and erosion in those three units.

The forced-draft fan is motor driven at constant speed. The induced-draft fan may be varied by adjustment of the hydraulic coupling between fan and constant speed motor. The combustion control adjusts stoker speed-changing devices to maintain steam pressure, controls forced draft, and controls induced draft.

Electric Power

Except for the two turbine-driven boiler feed pumps, one condensate elevating pump, and one hot well pump, all other boiler and turbine auxiliaries are driven by 440 volt motors. These are supplied with power from the main bus by the two existing 750 kva auxiliary power transformers. Generation is at 4160 volts. Electrical controls are operated by direct current from motor generator sets, with a storage battery floating on the line. The interconnection of the electrical distribution system with the transmission system of Illinois Power Co., through the substation adjacent to the plant, is to provide for emergencies. The electricity is generated at 4160 v and fed through a 4 wire system to 15 load centers located around the campus, where it is carried by cable to individual buildings and to

(*Continued on Page* 50)

BONEYARD BILGE

ENGINEERING FOR NON-ENGINEERS

by Millard Darnall
Ag.E. '56

Finally the gap between engineers and non-engineers is slowly closing. The General Engineering Department here at Illinois is offering a course this year of the philosophy and methods of engineering to non-engineers only. The number of this course is G. E. 250. This course on campus is termed as "a bridge across Wright Street."

The purpose of G. E. 250 is to acquaint non-engineering students with some of the problems and methods used by engineers and also with some of the historical development of the engineering profession. It is thought that the non-engineer would benefit from a course like this, since many times he deals with engineering and could make better appraisals of what falls into the domain of engineering.

It is the popular conception today to think of the engineer as a person with books in one arm and a slide rule in the other and figures running through his mind all the time. (Mathematical figures, of course). The purpose of this course is to bring into view the amount of technical material engineers must take and how this knowledge has affected the social and industrial aspect of the world through the years. This course has shown to be of great interest to wives and fiancees of engineers.

The course is divided into four parts. The first part deals with history and how engineering developments effected various historical developments. Most history courses deals with primarily the political, social, and religious developments and how they effect our lives. Along with these three, the viewpoint of engineering and engineering developments is discussed and how engineering also played an important part in the world.

The second part of the course deals with the characteristics of engineering and defines an engineer. They discuss all the requirements needed for a good and effective engineer. The different phases of engineering are discussed and just what each field contains.

Another aim of the course is to acquaint the student with typical problems of the engineer. Many problems are discussed and worked using the principle laws and formulas of physics and mathematics. The procedure of solving an engineering problem is stressed and how this method is useful in solving any other problem in any phase of life.

The last phase of the course deals with the sociological aspects of engineering. The effects of engineering on industry, education, family life, and labor are discussed. It was through engineering that mass production was started. This caused industry to boom and labor to lag. Through inventions of skilled machines, skilled labor was not needed as much in factories as before. This resulted in the formation of the unions. This is but an example of the many other connections between engineering and society.

A sequal to this course is also offered to engineers. The course number is G. E. 220. This deals mainly with the history of engineering from ancient times to the present and the social effects of engineering. Because of the amount of technical courses taken by the engineer, the section of engineering problems is omitted. Also the one dealing with defining of an engineer is left out. G. E. 220 is an elective course for engineers.

Mr. Dobrovolny is the instructor in both G. E. 220 and G. E. 250. He too, could be considered a pioneer as he started out this year on something new. He had to set up the entire course during the summer. He also has revived G. E. 220 to where it follows G. E. 250. These courses are both very useful courses to engineers and non-engineers.

Through this course and others which we hope will soon follow, it is believed that the philosophy of engineering will be brought to other students. At the present time, Illinois is the main figurehead in building such a "bridge." Other universities and colleges are watching carefully how this plan works. If it is successful, no doubt there will be comparable courses offered in other schools.

TV SLEUTH

Industrial television turned detective during the past summer and solved a case by giving police an eye-witness view of thieves at work.

The locale was a stockroom of an RCA television service branch in Hollywood. Inventries had disclosed that television equipment was being stolen on a substantial scale—some $38,000 worth (covered by insurance) was missing on the initial check.

Officials on the spot, recalling the success of RCA industrial television equipment in function as an "eye" in locations too dangerous or inconvenient for human observers, decided to try the device as an electronic witness to the crime. Summoning the police, they concealed the camera unit among the rafters of the stockroom with the lens focused on the loading platform. The rest of the unit—the TV receiver and viewing screen—was placed in a second-floor room some distance away.

Every day for two weeks, the TV "eye" was trained on the loading platform as police watched at the receiver. The camera recorded the routine activities at the platform—but it also recorded the suspicious actions of one clerk, who casually placed a number of boxes of TV tubes on the loading platform during the lunch hour on

Tuesdays and Thursdays when few other people were around. At apparently pre-arranged intervals, a pick-up truck would back into the driveway, the boxes would be put aboard with the help of the suspect, and the truck would pull away—all before the gaze of the camera and the interested watchers at the TV screen.

Once the facts had been made clear by the TV unit, the trap was set. The police at the reicever waited until the truck took off with anoher load of tubes. As they moved in to arrest the clerk, a police car trailed the truck to its destination and seized the driver and two alleged confederates.

The hero of the story is an industrial TV unit which already has been put to scores of uses—patrolling, guarding, transmitting fingerprints and signatures, checking numbers of freight cars, supervising operations of machinery at a distance, riding rockets, and generally fitting itself handily into locations where direct view is required and the human eye cannot go.

Its efficiency in these operations, and in its newly-acquired detective role, stems from the compactness of the camera and the fidelity with which it transmits what it sees. The RCA Vidicon tube, heart of the system, is only six inches long and an inch in diameter. The camera that is built around the tube is no larger than a 16-mm movie camera and is easy to handle.

The unit is completed by a connecting cable and a compact control monitor with a ten-inch viewing screen. Other receivers can be attached to the monitor if required, and the controls allow the camera focus to be controlled from the receiving end.

Although TV in this compact form has been available to industry for less than ten years and has been developed into its present state within the past two years, it has already carved a vital role itself in a wide variety of jobs. Its recent performance in Hollywood was a new departure, however, and its success as a witness to crime promises to open a broad field for TV as an electronic arm of the law.

ABBOTT POWER PLANT . . .

(*Continued from Page* 46)

a transformer. The voltage is then reduced from 4160 v to 120 volts single phase.

Automatic Operation

The plant is automatic to the nth degree. It requires only three men per shift to completely operate and maintain the entire Abbott power plan. From the minute the coal is brought in on the railroad cars it is handled automatically. About the only things that are operated manually are the electronic switches and buttons on the emense control panel which is nearly as long as the building. Mr. Gordon V. Carlson, superintendent of utilities, thinks that the Abbott Power Plant is one of the most modern in Southern Illinois. He states that they go further to try and eliminate the soot nuisance from the boilers than most plants. The two chimneys are 200 ft. high, nearly the highest structure in this locale. The reason for this was to discharge the gases in the air so they would be dispersed over a wider area. The original chimney is concrete and the newer one is brick.

Design of the original Abbott Power Plant Station and steam and electrical distribution system was carried out by Sargent and Lundy, consulting engineers, Chicago, cooperating with the Physical Plant Department of the University of Illinois which maintains and operates all the physical services of the University.

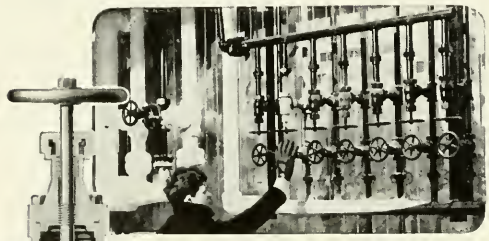
Bill: "The girl I am married to has a twin sister."

Mac: "Gee! How do you tell them apart?"

Bill: "I don't try. It's up to the other one to look out for herself."

* * *

First engineer to second engineer, "You drive, you're too drunk to sing."



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New Law Campus

by Donna Rudig, E. Physics '57

The new law building, to be built on the site of the old R.O.T.C. stables, will be the first building of the contemporary style on the campus. It will be a combination of completely solid walls, and walls entirely of glass with spandrels and window trim of aluminum. The material for the solid walls will be the red brick and limestone which was used in the other buildings on campus. Professor Richardson of the University Architecture Department designed the building with the approval of Professor Sullivan of the College of Law, and the Building Committee.

DONNA RUDIG

Donna is a freshman in Engineering Physics, and a pledge of Alpha Delta Pi sorority. She has the distinction of being one of the few women students in engineering at the University of Illinois. She is a native of Chicago.

The basic design of the structure is two blocks, one 192 by 144 feet, and the other 168 by 168 feet, separated by a 140 by 16 foot hall. The large block will be two stories high and between the two blocks will be an inner court. The cost of this structure is to be $2,460,000 which includes a $160,000 contingency fund. Workings drawings are to be ready by February 1, and bids will be open from February 15 to March 1.

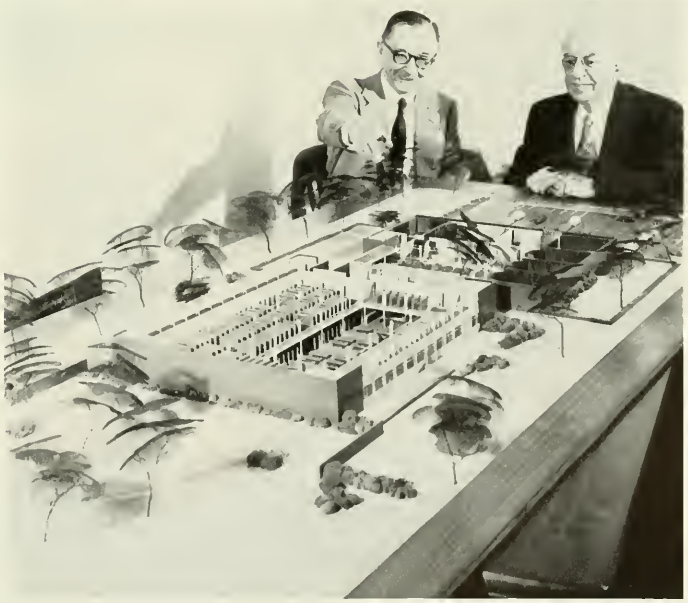
In the small block will be five classrooms, a miniature courtroom, auditoriums, and a Student Lounge. The absence of windows will be a noticeable feature of the building and all lighting and ventilation will be artificial; this is to help eliminate distracting disturbances and make classes more effective. All the classrooms also will be equipped with screens as well as blackboards so that visual teaching can be used to a greater extent that it now is. Theater type seats will be found in the lecture hall. This hall will have a capacity of 324 persons and will be of the auditorium type. A screen for motion pictures will be one of its other features. The practice courtroom will be a duplicate of the United States District Court at Peoria, Ill. On the west side of the block will be located the student lounge. Since its main purpose is for relaxation it will be made as domestic as possible. The lounge will have the ony wooden floor in either block, the rest being cement, and there will be drapes at the windows which compose one complete side of the room. The window will be facing the inner court. A small kitchenette will be installed in one corner of the lounge for those who are hungry between classes.

Two seminar rooms for small class discussions, faculty offices, and the library will be located in the large block. The north side will be the faculty offices, all having the same orientation and being the same size. This similarity of offices will tend to eliminate any controversy there might be over the question of which person should have the largest office. All of the offices open directly onto the reading area of the library making ready access to any necessary reference.

The library will have the standard ceiling height of ten feet, making it possible to have seven and one half foot stacks. This will leave a two and one half foot clearance for air circulation eliminating to a great extent the musty odor which is common to libraries. The stacks will be movable so that reading areas may be developed wherever they are most needed. There will be a special room to contain the micro-film and micro-file. Also off the main reading room will be a typing rom; this will enable students to type needed material directly from the books .

The open stack method, which allows students to find their own books instead of having to ask the librarian, will be used almost entirely. The exception will valuable or nonreplacable books which will be enclosed in a separate room. Though it is quite possible that more books will be lost by using this method, the College of Law feels that the library will be used more, which is more important than a few lost books. The only control desk will be at the main entrance, but the possibility of persons slipping through outside doors is eliminated since all the other exits are for emergency use and the only way to get out them is by breaking the glass doors.

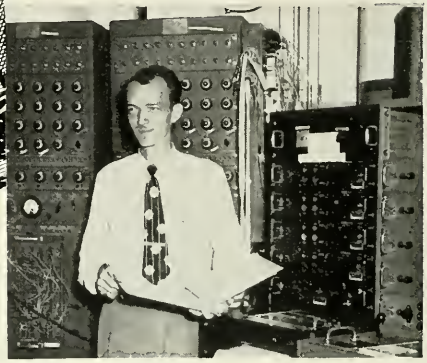
The second floor library will be reserved for the faculty and for visiting



Dean Albert Harno (left) of the College of Law shows Lloyd Morey, president of the University of Illinois a model of the new law campus.

NEEDED--- A NEW APPROACH!

HE HAD ONE



Prime contractors to our Armed Forces—M. A. C. is engaged in the design, development and production of airplanes, helicopters and guided missiles. One of the newer products of McDonnell ingenuity, the F101 Voodoo, will soon join the arsenal of the U. S. Air Force.

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Assistant Chief Dynamics Engineer — Missile Engineering Division
B.S.A.E. Iowa State College '45
M.S. Applied Mechanics Washington University '52

Pictured in front of our REAC installation, Bob Sharrah exemplifies the type of pioneering spirit essential in missile engineering. He developed a new and useful approach to the problems of stability of guided missile control systems as influenced by aeroelastic effects. At twenty-eight, Bob also points up the youthfulness of M.A.C.'s engineering management.

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McDONNELL *Aircraft Corporation*

A model of the new law campus to be built at the University of Illinois.

lawyers and judges who are engaged in research. This library takes the place of faculty research laboratories in the science buildings. On the south side will be offices for the visiting lawyers, and it is expected that there will be many, for this library is one of the best in downstate Illinois. Reading rooms with the outside wall almost completely glass also will be located on the south side, being separated by partitions of minimal size.

The rest of the second floor will be taken up by the administration. It is there that the offices of the president, vice president, etc., of the college will be located. This also is the location of the stenographers which comprise the stenographic pool for the faculty. There will be a large conference room for meetings on this floor also.

In the basement will be stack space for further expansion of the library when future need arises. Space also is being provided for mechanical equipment and a compressor for future air conditioning. Separate locker rooms for men and women also will be located in the basement. The lockers will be large enough to contain a typewriter, as well as coats and books.

The 16 foot corridor connecting the two main blocks will be stone paved and have both sides glass to provide an exterior feeling as a contrast to the "shut in" classrooms. All parts of the building have been designed for simplicity and utility.

CAN YOU READ THIS?

Seville dair dego
Tousin bussis inuro
Nojo demstrux
Sumit cousin
Sumit dux

Having trouble? Read it faster and if you still can't get it, here all it says:

See, Will, there they go—
Thousand buses in a row.
No, Joe, them's trucks.
Some mit cows in,
Some mit ducks.

How to lick dust, moisture and acid fog

prevalent in the atmosphere surrounding the Rumford, Me., mill of the Oxford Paper Company posed a problem in power circuit maintenance. The combination of these elements caused wooden structures and even over-voltage insulators to become conducting, resulting in phase-to-phase flashovers and burndowns when ordinary overhead wires were used.

The solution of this serious problem was found by substituting Okolite-Okoprene Self-Supporting Aerial Cable for the open wires. According to company officials, the combination of Okolite high voltage moisture and heat resisting insulation, protected by non-conducting weather and chemical resistant Okoprene sheathing, has eliminated this trouble.

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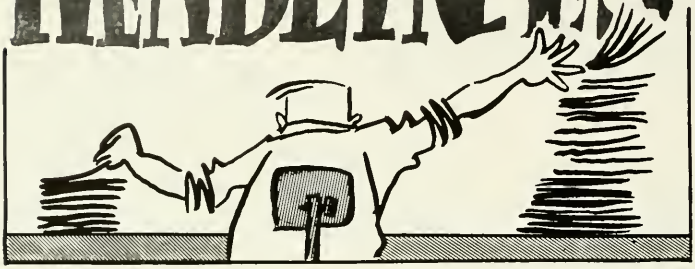


by Larry Keifling, M.E. '56
and
Warren Conner, M.E. '56

Titanium for Jets

Titanium now seems assured of a place in jet engines. This point has been reached only because metallurgists were convinced that, in spite of tremendous obstacles to the production and use of titanium, the advantages to be gained were outstanding.

Titanium has three qualities that grip the attention of jet men: (a) it weighs only two-thirds as much as ferritic materials but is equally strong; (b) it retains its strength up to about 800 degrees F, which is far above the limiting temperatures for aluminum; (c) titanium is almost completely unaffected by salt air and water, much more so than is aluminum. Even after the knotty problems of winning the metal from its ores at a cost wtihin bounds were solved, problems of how to machine titanium threatened to wreck the program. Titanium cannot be cut by ordinary techniques; it smears on the tool. Jet-engine metallurgists found the answer, partially, to lie in machining the material at a low temperature, created by bathing the tool on the work in a stream of evaporating carbon dioxide (–112° F).

The techniques of using titanium-alloy for jet compressor discs have been solved. Engineers are now working to reduce the cost, which is still high. Also, development work to use titanium for compressor blades is well underway. It appears that pure titanium metal, rather than an alloy, is preferable for blades. Titanium blades, in addition to their salt-air corrosion resistance, have a two-fold advantage accruing from their light weight for a given strength. The blades themselves are lighter and the compressor discs to which they are fastened can be made lighter because of the lower centrifugal stresses.

Color-tron

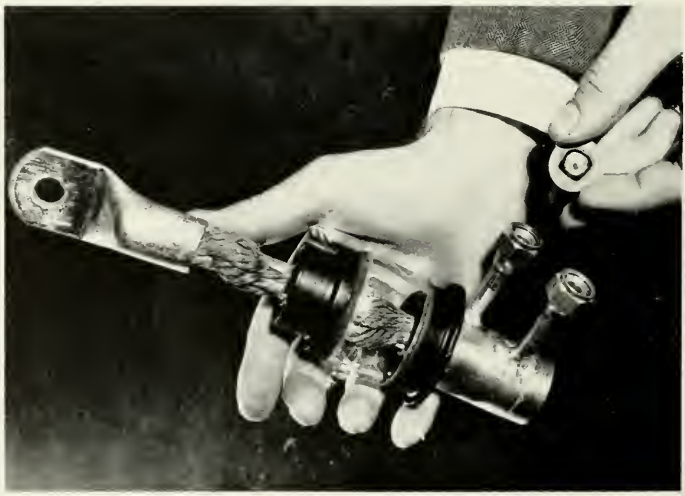
CBS Hytron, electronic tube manufacturing division of the Columbia Broadcasting System recently announced that the pertection of a process whereby color television picture tubes can be mass-produced with the same standards of quality realized in present-day black and white picture tubes.

The CBS tube, known as the "Color-tron," uses a curved-glass, face-plate containing 250,000 phosphor triads, each of which has one red, one blue, and one green dot. Behind this plate is a thin metal-and-glass sheet containing the same number of holes as triads. The phosphors are printed on the face plate by using each mask as an individual negative.

The new process, product of two years' research by CBS engineers, should bring the price of color television sets down considerably since it was the color television tube which formerly was responsible for its prohibitive cost.

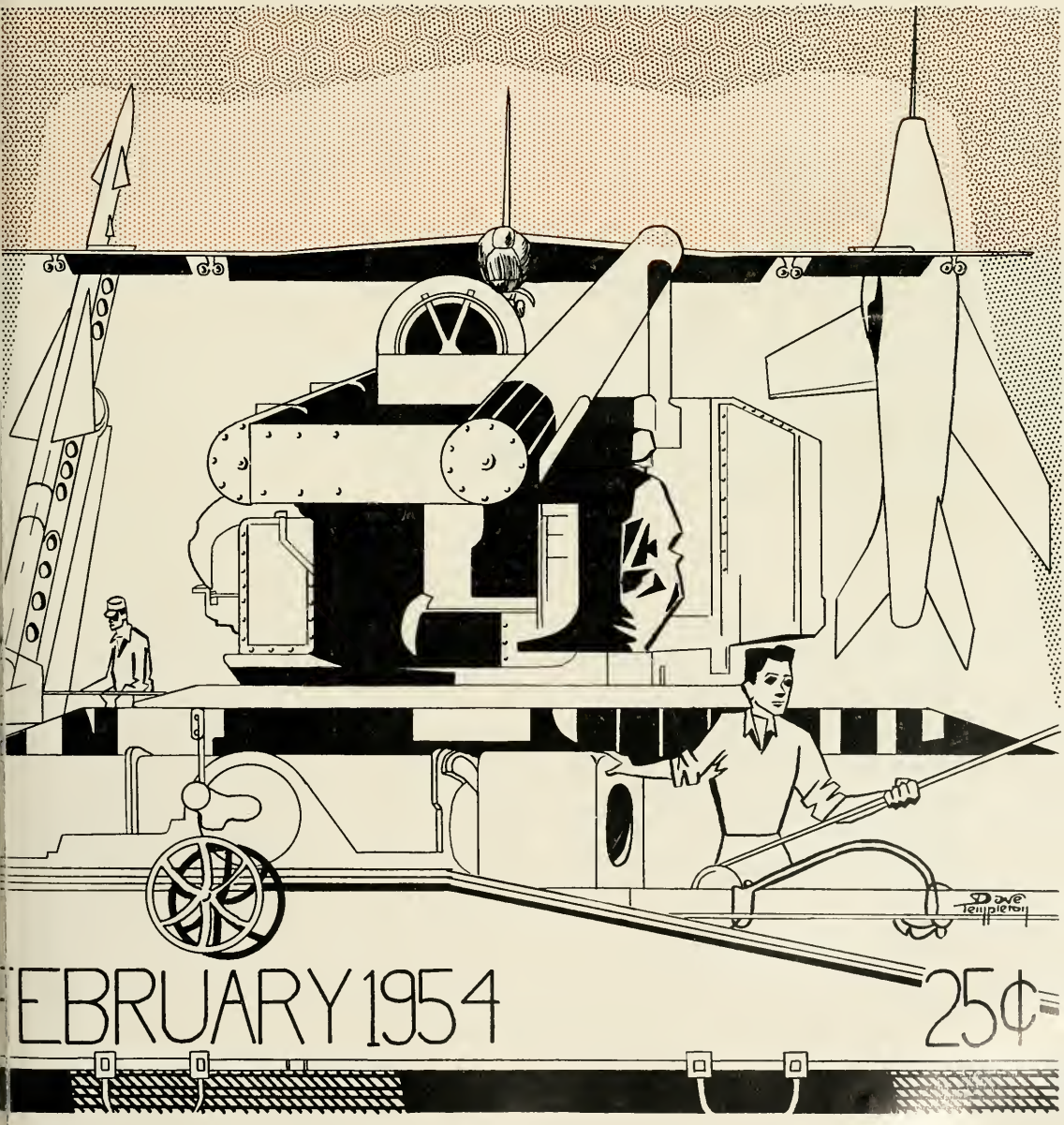
Water-Cooled Germanium Rectifier

In this experimental water-cooled rectifier, a wafer of germanium only 7/8 inch in diameter and 0.015-inch thick delivers 200 amperes (average) direct current at 100 volts. The rectifier is still in the developmental stage. While ratings are not yet exactly known the peak back voltage is expected to be about 110 volts and the forward voltage drop at 200 amperes average (600 amperes peak) about 0.8 volt.



Water-cooled germanium rectifier.

ILLINOIS TECHNOGRAPH



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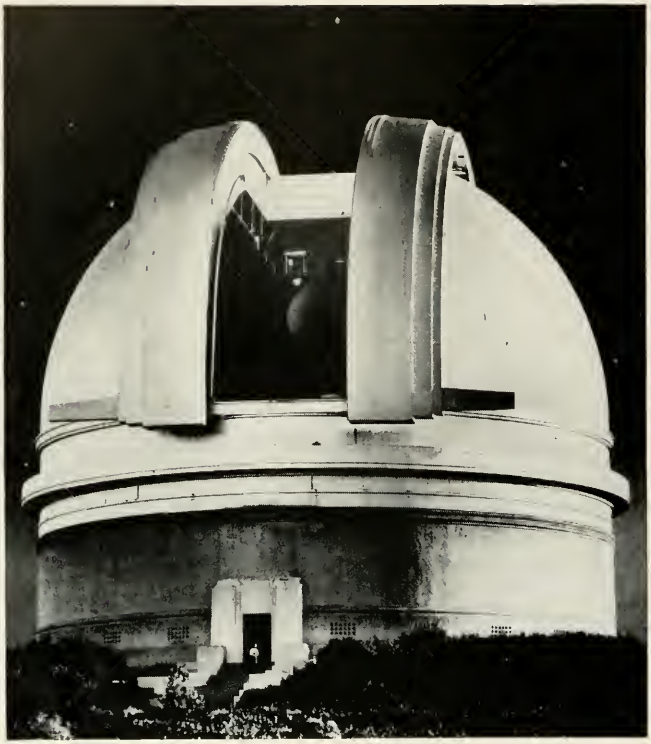
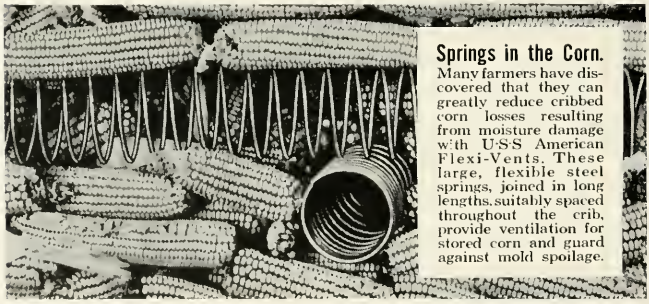
Only STEEL can do so many jobs so well



Steel and the Stars seem unrelated. But in almost every attempt man makes to learn more about his universe, to build bridges to the unknown, steel plays a vital part. Here, for example, in the Palomar Observatory housing the 200-inch Hale telescope—world's largest—the rotating dome with precision balanced shutters is made of *steel*, fabricated and erected by United States Steel. Only steel can do so many jobs so well.

Zoot Chute. In the processing of anthracite coal, the best-dressed coal chutes, these days, are wearing linings of Stainless Steel. For where ordinary carbon steel chutes wear out and have to be replaced in 2 months, chute linings of stainless steel give 5 years of efficient service. In addition to hundreds of tons of coal, 17,500 gallons of water flow over these chutes each day.



Springs in the Corn. Many farmers have discovered that they can greatly reduce cribbed corn losses resulting from moisture damage with U·S·S American Flexi-Vents. These large, flexible steel springs, joined in long lengths, suitably spaced throughout the crib, provide ventilation for stored corn and guard against mold spoilage.

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Published eight times during the year (October, November, December, January, February, March, April and May) by the Illini Publishing Company. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois, under the Act of March 3, 1879. Office 213 Engineering Hall, Urbana, Illinois. Subscriptions $1.50 per year. Single copy 25 cents. Reprint rights reserved by *The Illinois Technograph*. Publisher's Representative—Littell Murray-Barnhill, 605 North Michigan Avenue, Chicago 11, Ill. 101 Park Avenue, New York 17, New York.

THE ILLINOIS TECHNOGRAPH

volume 69 number 5

contents:

a "V" for vengeance ---- 9
jules verne, master of imagination ---- 13
percolating tea kettle ---- 17
pier pilings ---- 21
report on the 1953 engineering open house ---- 24
book reviews ---- 26
campus candids ---- 28
introducing ---- 32
the role of the engineer in the navy ---- 35
leonardo da vinci ---- 38
make-up of the tech ---- 42
skimming industrial headlines ---- 46
nuclear reactor is safe ---- 50
pipes of clay ---- 51
gospel according to st. joe ---- 55

our cover

Engineering plays a vital part in the military might of this nation. Shown on the cover are several military weopons, eoch dependent upon vast engineering knowledge. At the bottom is the otomic cannon, above that the "skysweeper" anti-aircraft gun and the Boeing B-52. At the left is the Nike anti-aircraft rocket and at the right is the F-100 fighter plane. (Cover by Dove Templeton)

our frontispiece

At the Knolls Atomic Power Laboratory near Schenectody, N. Y. is this huge sphere, as high as an 18-story building and containing 3850 tons of steel. The sphere is used to house the prototype of an atomic power plant for submorines. The big boll is said to be the largest of its kind and is made of inch-thick steel plotes joined together by more than five miles of welding. (Cut courtesy of General Electric)

Simple enough now, this vertical ascent was history-making in 1939.

You can remember
THE FIRST SUCCESSFUL HELICOPTER

Just two years *before* Pearl Harbor, Igor Sikorsky took the controls of a weird-looking machine — culmination of a dream of thirty years. Moments later it rose from the ground. Though the flight lasted only a few seconds, the VS-300 became the first practical helicopter in the United States.

Less than six months *after* Pearl Harbor, the Air Force took delivery of the first military Sikorsky.

Since then, rapid developments prove that the helicopter, most versatile of military aircraft, has tremendous commercial potentials.

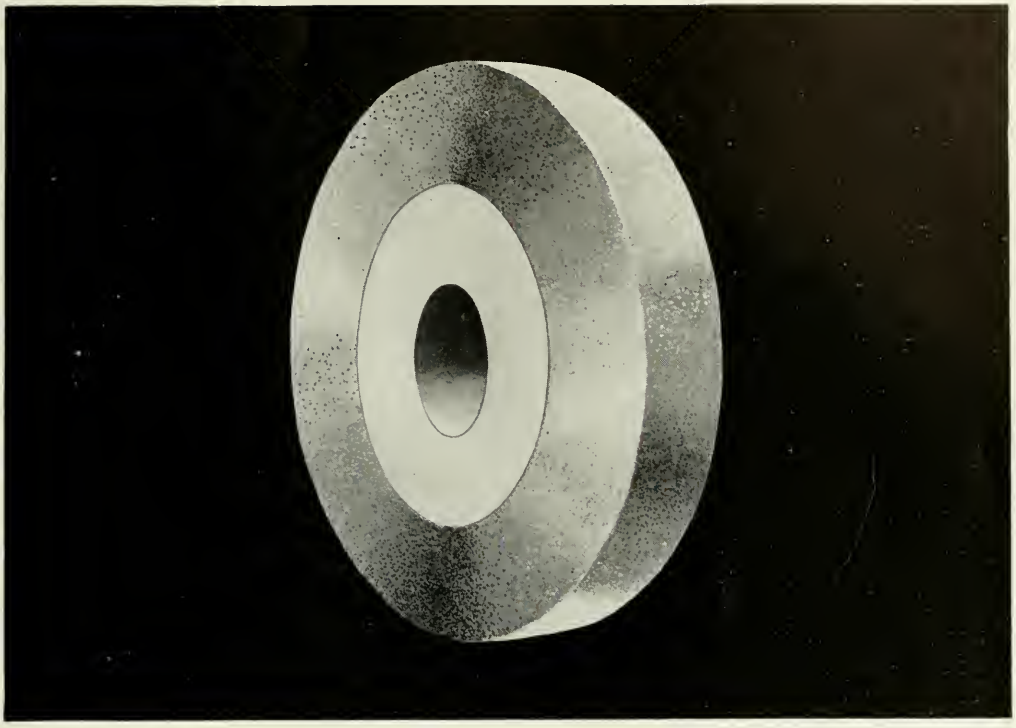
Helicopters of the future will be the product of tomorrow's engineers. Sikorsky is young and growing. It offers life-time opportunities to young men who choose work where their skills and abilities will be constantly challenged.

Perhaps *you* belong at Sikorsky — in the research departments, the drafting rooms, the engineering laboratories.

You can *remember* the first successful helicopter — you may be the man to *build* tomorrow's! Learn more about employment opportunities at Sikorsky from C. R. Banks, Personnel Department.

SIKORSKY

One of the four divisions of United Aircraft Corporation **South Avenue** **Bridgeport 1, Conn.**



HIDDEN HENCHMAN . . .

Early man used Nature's rocks and stones to shape and sharpen his crude tools and weapons. Today, industry has at its command abrasives that will do in seconds jobs that formerly required days of tedious toil.

Yet relatively few people know or appreciate the vital labor-saving, back-stage role which abrasives play in the production of practically all mechanically finished articles.

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McGRAW-HILL FOR BUSINESS

A "V" for Vengeance

by Jim Piechocki, Aero. E. '55

Any discussion on rockets and high altitude travel, whether carried on by technical minds or science-fiction enthusiasts, will invariably turn to the topic of the V-1 and V-2, the two Nazi terror weapons of World War II. Furthermore, no such discussion would be complete unless some time and thought were given to these two hideous creations — devices which struck fear into the hearts of Londoners in the waning days of the blitz. Yet the technical man cannot help but feel a spark of admiration for these two weapons because they represent one of the most outstanding engineering accomplishments of modern man. No one has yet dared contest this statement.

It would be difficult for one to trace the origin of the *V* weapons. Perhaps it could be attributed to men such as Von Braun, Oberth, Opel, or Valier—names which are synonymous with rocket achievement. And yet Valier with his rocket sled, Oberth with his amazing rocket theories, Opel with his rocket-powered glider, and thirteen-year-old Von Braun, happily scrambling about the early rocket experimenters, never can be given full credit for the creation of the V-1 and V-2. One has to go back even farther to the Nineteenth Century French experimenters, to the rocket siege by the Chinese in 1232 A.D., to the very idea of high-altitude travel expressed by the Greeks as early as 100 A.D. The V-1 and V-2 were the culmination of centuries of combined human efforts. No single man can assume the honor or the blame.

Where the Bay of Stettin joins the Baltic, there lies a small triangular-shaped island which seems to have been left unnoticed by civilization. Passengers on the Baltic avoided it for the simple reason that it had nothing to offer in the way of picturesque scenery. But this did not deter the German government. Nor did it quell their interest, for it was here in 1937 that the first rocket research institute was founded. The name of the place — Peenemunde. Its purpose — the production of explosive-carrying rocket weapons. Very few knew the name then. Today Peenemunde stands for V-2.

In early 1942 the British were well aware of the "goings-on" at Peenemunde. Reconnaissance airplanes photographed the entire area with no resistance whatsoever. In fact, early photographs revealed what appeared to be a tiny airplane posed on a launching ramp. This was their first glimpse of the V-1. It was not their last. After a clever bit of strategic stalling, the British decided to strike. And strike they did, for on August 17, 1943, a very costly, but very successful raid was directed upon Peenemunde and the institute. It occurred at a convenient time too, because approximately 7,000 researchers and officials were assembled there. Postwar investigations revealed that 1,000 perished in the raid, among them some of the most illustrious names in the rocket field. But it came too late. The V-1 and V-2 already were being mass-produced in German factories.

The first V-1 crashed in the London area late in the evening of June 12, 1944. To the surprise of the experts, it was no rocket. Its means of propulsion was a long "stovepipe" duct which was actually a small jet engine in itself. The rear of the duct was open while the front contained a system of shutters which swung inward. Combustion consisted of intermittent explosions in the duct which closed the shutters at the front. The expanding gases rushed out of the rear of the duct, thereby dropping the pressure in the tube. Hence, the shutters flew back and allowed another rush of air to be mixed with a fine fuel spray. Low-octane aircraft fuel was used.

The length of the V-1 was 25.4 feet. The stubby-looking wings spanned 17.67 feet. It had a maximum range of 150 miles, although a few were known to have flown as far as 170 miles from their launching site. Top speed was 360 miles per hour, just above that of the British Spitfire which was called in to defend London. The V-1 had a total weight of 7,000 pounds. Its warhead, loaded with explosives, weighed 2,000 pounds and held a very sensitive detonating device which exploded the bomb on contact, thereby causing the greatest damage possible. Before its engine could function, it required an airspeed of 150 miles per hour. Therefore it had to be given an initial "push" at takeoff. This was accomplished by a huge piston which was enclosed in the launching ramp and driven by compressed air. On some occasions, a rocket-powered carriage was used to start the bomb on its journey. Once airborne, the V-1's propulsion duct began functioning and quickly accelerated the missile to its top speed. After several minutes of level flight, a clockwork mechanism locked the elevators in a down position, thereby pointing its nose earthward and causing the remaining fuel to flow away from the engine duct. This cut the power and sent the V-1 roaring in for the kill.

The V-1 had many serious drawbacks, the most outstanding being its inefficient engine. Many times did it fail to start after the bomb was given its initial velocity, and therefore the launching crews were subjected to great dangers. It must have been a hideous sight to the crews to have the deadly bomb come staggering back to earth after its short flight. Another shortcoming was the fact that the bomb was easily spotted in flight by observers who relayed their sightings to the ever-present antiaircraft batteries.

The defense of London against the V-1 remains as one of the most valiant civil defense efforts in history. The most serious problem for the defenders was the altitude that the bomb attained. Had it flown 6,000 feet the heavy 3.7 inch antiaircraft guns would have had no difficulties with it. Or had it flown around 1500 feet the 40 mm Bofons — light, quick firing weapons — would have handled it easily. But the V-1 actually flew between 2,000 and 3,000 feet, that is, too low for the big guns, and still too high for small arms fire. That the British overcame this problem is now a well known fact. RAF and Polish

pilots soon discovered that they could make up the speed deficit by diving from a high altitude upon the bombs and getting them in their sights for that all important fleeting instant. They also delicately maneuvered their craft alongside the bomb and tilted it over with their wing tips, sending it spiraling to the ground. Another method was discovered accidently when an American pilot overshot his target and dived in front of the bomb. The turbulent slipstream upset the missile and sent it into a dive. Needless to say, this method was employed quite frequently. Balloon barrages were also effective and on one occasion accounted for sixty V-1's in a single day.

The V-1 took a high toll: 5,864 killed, 17,197 injured critically, and 23,174 slightly injured. Damage to property was widespread. The first V-1 precipitated that hateful, oft-heard, BBC report which was to be heard throughout the maddening siege: "Damage was caused and there were some casualties."

But the German front was already receeding under the pounding Allied attack. Their lines of battle were moved back beyond the 150 mile range of the V-1, and consequently the bombings became quite infrequent. By August 30 of that year V-1 raids had dwindled to insignificant proportions. In the short space of two months over 2,000 V-1's had fallen on London. Suddenly the raids stopped completely and Londoners breathed a sigh of relief. The history of the V-1 was finally at an end.

On September 8, 1944, the first V-2 fell on London.

Here was an entirely new weapon, bringing with it a new terror to the British island. The same old purpose was there, however, and many feel that this fantastic weapon was the last frantic effort of a maniacal despot to strike back at his conquering foe. It was the same old story, man's inhumanity to man, repeated over and over again, this time in the form of a rocket-powered monster. The Fuehrer himself ordered mass production after viewing films of research successes. The Propaganda Ministry changed its industrial designation from A-4 to "Vergeltungswaffe Zwei"—V-2.

The early experimenters must have been hardy souls considering the failures they encountered. The first V-2 was test-fired on July 6, 1942, and rose three feet off the ground, fell back, toppled, and exploded violently, destroying the entire test station. The second exploded at a height of 16,000 feet, No. 3 did the same. But No. 4, fired in October, 1942, was a smashing success, as was No. 5. The next thirteen attempts were all failures, the missiles either failing to take off, exploding in mid air, or breaking in two. Had No. 19 not performed successfully, the entire project might have been abandoned.

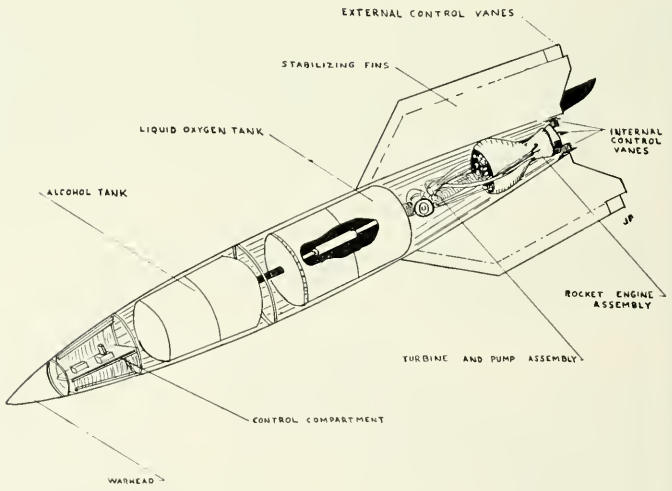
All research was not carried on at Peenemunde. The small town of Blizna, Poland, was evacuated to make way for an elaborate test station. Here loaded V-2's were made ready for one of the most vicious experiments in the history of mankind. The target was the tiny village of Sarnaki, just 150 miles north of Blizna. The 1,000 inhabitants were forced by the SS to remain in the town and lead as normal a life as possible. Over one hundred V-2's were fired on Sarnaki in an attempt to discover the extent of damage that a bomb could cause. No direct hits were made. The results could hardly be called encouraging because very few casualties resulted, and if the test proved anything, it made clear that the V-2 was not an accurate weapon; but German factories continued to turn out parts at an ever increasing pace.

The V-2 greatly resembled an oversize aircraft bomb. Weighing 12½ tons, it had an over-all length of 46 feet. Its nose held deadly amatol, a mixture of ammonium nitrate and TNT. Directly behind the warhead was the instrument compartment. It housed a set of gyroscopes and an automatic device which shut off the fuel supply when the proper altitude and velocity were reached. Called the "Integrationsgerat," or integrating accelerometer, this latter device constituted a major achievement in itself. Next in line came to two fuel tanks. The alcohol tank was forward of the liquid oxygen tank and the fuel had to be pumped through the oxygen tank by means of a pipe running inside the latter. Both tanks employed glass wool insulation and were slightly pressurized to avoid their collapse when partly empty.

The power compartment contained two of the greatest engineering achievements of modern man — the fuel pumps and the rocket engine. It was the invention of a workable fuel pump that made the operation of the V-2 possible. The pumps had to be light, rugged, and deliver the fuel with a pressure of 350 pounds per square inch. Fuel injectors had the gigantic task of vaporizing and mixing 287 pounds of propellants a second!

And yet the most amazing feature of the entire project was the rocket engine. To fully realize the significance of this development, one must merely review the staggering demands placed on the powerplant. It had to burn that huge volume of fuel in a space only three feet (length) by three feet (diameter). The chamber and nozzle had to be kept cool in spite of an exhaust blast scouring the walls at a velocity well over a mile a second and at a temperature of 3,000° Fahrenheit.

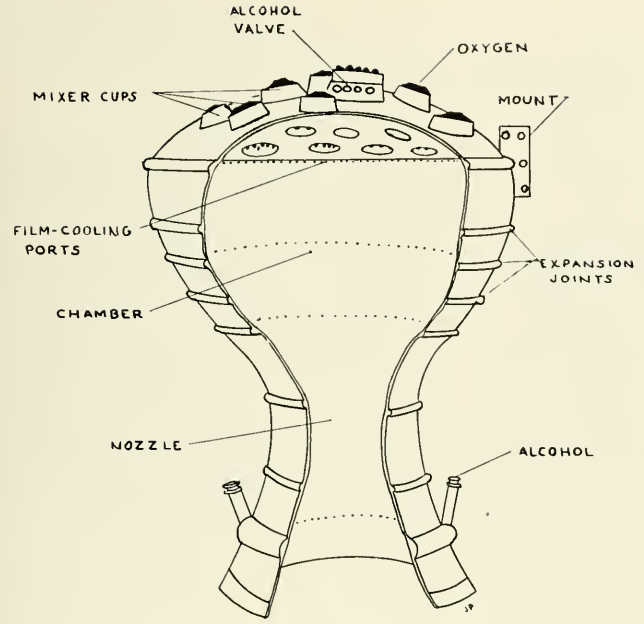
The contraption which accomplished all these things was a clumsy-looking affair which, as James H. Wyld said, ". . . had as its most striking feature its very lack of striking features." This pic-



VERGELTUNGSWAFFE ZWEI

V-2

A cutaway drawing of the German V-2 rocket.



The propulsion unit of the V-2 rocket.

ture of simplicity was capable of developing a thrust of 60,000 pounds at sea level. That is about ten times the thrust developed in the majority of today's jet powerplants. Looking into the rear of the engine, one would see a series of 18 cups at the distant end of the chamber. They were arranged in a small circle of six surrounded by a larger circle of twelve, and they resembled large salt shakers. The alcohol was ejected into the chamber through tiny openings while the oxygen was injected through a dome-shaped insert in the top of each mixer cup. Combustion occurred at the burner cup-mouths. Many tiny apertures lined the chamber and nozzle and through these alchohol was spilled onto the inner walls. This created a protective film which cut down heat absorption by the metal. Alcohol was also pumped through a surrounding jacket before it entered the cups and thereby assisted in the cooling of the engine. The utilization of the fuel itself as a coolant was just another in the long series of ideas which made the V-2 a successful weapon.

The exhaust blast was quite long. Emerging from the nozzle at a velocity of 7,000 feet per second, this hot column provided the most effective means of controlling the flight-path of the V-2. A series of four vanes reached down into the jet blast and provided the ground operator with a remarkable degree of control. Another set of vanes was contained in the rear of the external "tail-fish" fins at the back of the V-2. Initial control was important because the missile was extremely unstable in its first few seconds of flight.

The V-2 needed no launching ramp or tower. All that was necessary was a reasonably flat area of ground about 40 feet in diameter. All radio and electrical equipment was preset before firing. Only then was the highly volatile oxygen fuel pumped into the tank. Ignition was accomplished by a slow-burning, black powder cartridge which was ignited electrically. The valves were then opened, permitting the fuel to run freely into the engine. When the launchers saw that the engine was burning properly, the turbine which ran the fuel pumps was started. With the fuel now being forcibly fed into the engine, power increased. The low rumble of the rocket became a roar, then a scream, and seconds later the V-2 rose like a huge bird slowly into the air on its mission of death. And the launching crew, tense with emotion, broke into jubilant cries as the rocket became a speck in the sky above.

At the end of the first second it had a velocity of 38 feet-per-second. After two seconds of flight, its airspeed was 76 feet-per-second. It lost weight quickly (287 pounds-per-second) and hence its acceleration increased rapidly. After eight seconds of vertical ascent, the control vanes tilted the rocket to an angle of 45 degrees. At a height of 22 miles the engine produced 69,000 pounds of thrust. At this altitude it was just approaching its peak velocity of one mile per second, or 3,600 miles per hour. At just the proper instant, the Intergrationsgerat stopped the engine. The V-2, with no power, rose for another 35 miles due to its tremendous momentum. During this period it slowly lost speed, and after approaching an altitude of 59 miles above sea level, it began its journey earthward. Five minutes after takeoff the bomb struck its destination with a velocity of 1,100 miles per hour. Since this is supersonic speed, the V-2 could not be heard. It could be seen, however, because the air friction (due to such a large velocity) heated the entire missile to a dull-red glow. But to most of the Londoners, the warning of the V-2's coming began — and ended — with a deafening explosion.

A total of 4,300 V-2's were fired, with 2,000 crossing the English coast, and 1,230 falling on London. During the interval between September 8, 1944, and December 23, 1944, Londoners underwent even more psychological strain than during the V-1 assault, for they came to realize one glaring fact—against the V-2 there was no defense.

But Allied superiority to the East brought about a subsequent halt to the launchings. This could not have come soon enough, because only Moscow and the Pentagon now know how close Nazi researchers were to the perfection of an atomic missile. Then, too, something even more hideous was taking shape on the German drawing boards—the A-9 and A-10, and Hitler's fantastic plot to rocket-bomb New York.

And what remains today of the V-1 and the V-2? The information garnered by the German experimenters now is being used by U. S. researchers on the vast deserts of New Mexico and on isolated Pacific islands. Many famous men, Von Braun one of them, now are working on rocket projects for the Armed Forces. Then too, many of the illustrious have disappeared behind the Iron Curtain. It takes no superior intellect to deduce what these men are "working" on. One solitary fact remains: The Nazis had horror weapons in 1944 — we have them now.

And where the Bay of Stettin joins the Baltic, Peenemunde, that small triangular-shaped island, once again lies unnoticed by civilization. There are a few barren patches where green foilage never will grow again. Jagged walls throw up their sides and stand as mute statues —mock symbols of the activity that once was there.

Jim Piechocki

Somehow, somewhere, meet we must.

How Men Met in the First International Conference On Standards

The first full-scale formal conference on international standards was held almost 80 years ago. After five years of preliminary work, the "plenipotentiaries of most of the leading occidental nations," including the U. S., met in Paris in the spring of 1875 to attend an International Conference on Weights and Measures. Of the 19 nations present, 17 signed a convention which provided for the establishment and maintenance of a permanent International Bureau of Weights and Measures to be situated near Paris. The French Government set aside a plot of ground in the Park of St. Cloud for the Bureau and declared it neutral territory.

The latest international meeting on standards was the Second Triennial Plenary Session of the International Organization for Standardization (ISO) held June 9-21, 1952, in New York. Thirty-four national standards bodies belong to the ISO, the American Standards Association representing the United States.

Through History with Standards

Courtesy American Standards Association

How the Movies Built an International Market for Their Films

In the early years of the motion picture industry, stoppages and imperfections in films were common. They were caused by irregular perforations and perforation spacings in the film, by non-standard motion picture machinery, and by non-standardized methods of handling film and equipment. In 1916 the Society of Motion Picture Engineers cited such stoppages as a main cause for the lack of popularity of motion pictures among large numbers of people.

Standards have completely eliminated these difficulties. The industry is now highly standardized in processes, product and procedures, not only in this country but internationally. After the American Standard for the location of the sound track on 16-mm film was adopted internationally in the 1930's, many other motion picture standards were internationalized. The ASA Sectional Committee on Standards for Motion Pictures, PH22, made up of 32 organizations, has developed more than 60 American Standards, and many of these have found world-wide acceptance.

Today, motion picture film from one country can be projected in the standard equipment of any other country in the world.

A weak and niggardly projection.

Jules Verne

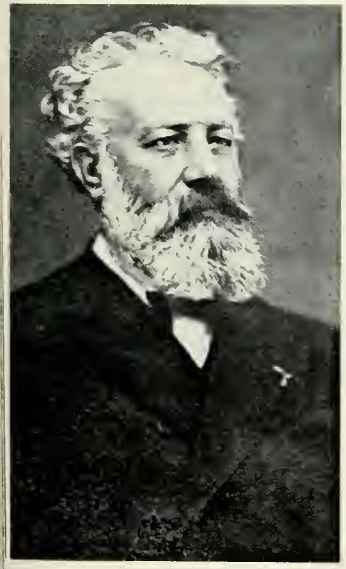
. . . Master of Imagination

by Donna Rudig, E. Physics '57

Jules Verne, one of the early masters of science fiction who's "Twenty Thousand Leagues Under the Sea" and "Five Weeks in a Balloon" have become well known, was born in Nates, France, 1828. As a young boy, he was fond of adventure and talked to the sailors in port whenever he got the chance. At the age of twelve he tried to ship out as a cabin boy but was caught by his father, and taken home before the ship sailed.

Though Jules studied law, his active mind was soon busy in the more versatile field of literature. He obtained work in the theater and then wrote a comedy in verse which was produced. At the age of twenty-nine he married and settled in Paris as a stockbroker, contenting himself to writing plays and librettos as a sideline.

About this time he joined the Scientific Press Club in which the members were currently fascinated by the possibilities of the balloon. Jules, even more interested in the balloon than were the other members, began work on a story "Cing Semaines en Balloon," or "Five Weeks in a Balloon" which was published in 1862 or 1863. The public liked the novel so well that the publisher offered him a contract to write two books per year for twenty years for the sum of $4,000 per book. The then unexplored field of scientific adventure seemed like a gold mine to Jules, who agreed to the terms of the contract.



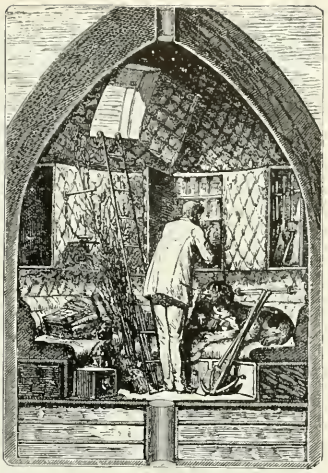
Jules Verne (1828-1905)

He studied widely in science and geography to get new ideas, and often based his stories on inventions of the day by foretelling their subsequent technological developments. In 1864, he published "A Voyage to the Center of the Earth," a story of the adventures of men who journeyed to the earth's core by means of a passage in the crater of Mt. Vesuvius. His stories seemed so plausible that when "From the Earth to the Moon" was published, many people offered to accompany him if he journeyed to the moon. "Around the World in 80 Days" was first serialized in a Paris newspaper "Le Temps," and people laid bets on whether or not the hero, Phineas Fogg, would reach home in eighty days; Paris correspondents of newspapers in the U. S. cabled home summaries of the chapters as they appeared. "Twenty Thousand Leagues Under the Sea," written in 1869, was suggested to Verne by accounts of the ocean bottom which he heard from sailors of the "Great Eastern," who had just laid the first trans-Atlantic cable.

In honor of several of his romances, Verne was made a member of the Legion of Honor, and was crowned by the French Academy. This quasi-scientific writer prophesied among other things, submarines, dirigibles, television, gas bombs, and talking pictures. Though primarily a novelist, at heart, Verne was also partly a theoretical engineer in dreaming up the ideas for his books, "Michael Strogoff," "The Adventures of Captain Hatteras," "The Purchase of the North Pole," "Christopher Columbus," and the others.

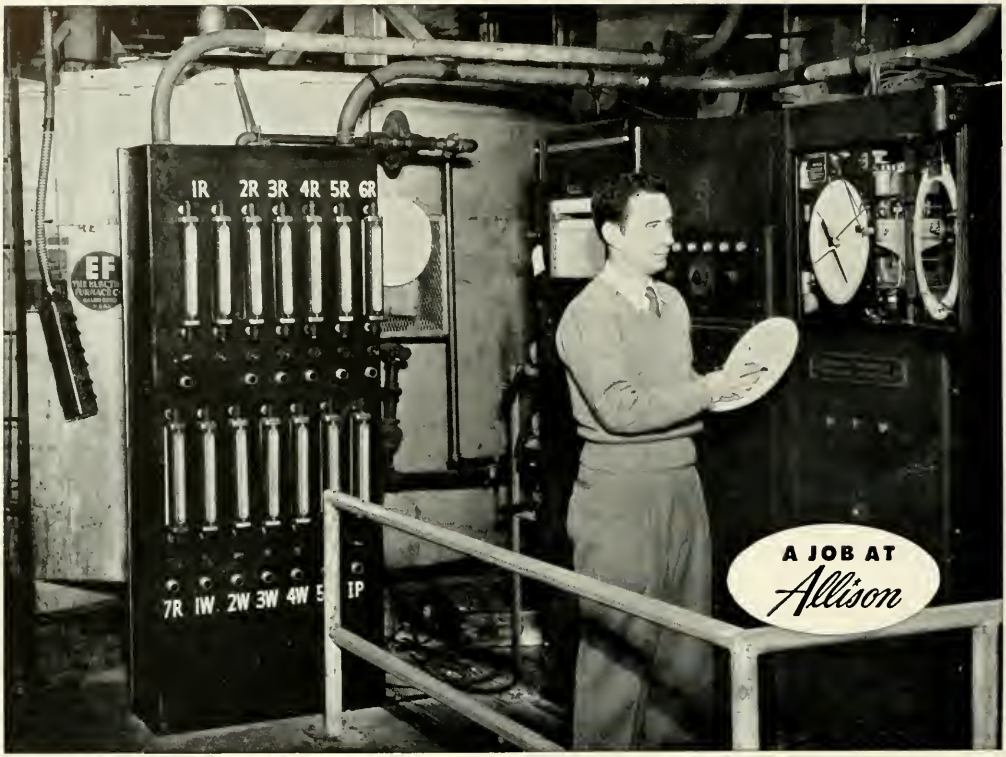
Books by Jules Verne

1863—Five Weeks in a Balloon
1864—Voyage to the Center of the Earth
1865—From the Earth to the Moon
1866—The Adventures of Captain Hatteras
1868—The Children of Captain Grant
1870—Around the Moon; Twenty Thousand Leagues Under the Sea
1871—A Floating Village
1872—Meridiana, Adventures of Three Englishmen and Three Russians
1873—Around the World in Eighty Days, The Fur Country



Making preparations inside the lunar rocket, in "From the Earth to Moon."

1874—Doctor Ox
1875—The Mysterious Island; The Chancellor
1876—Michael Strogoff
1877—Child of the Cavern; Hector Servadac
1878—The Boy Captain
1879—The Begum's Fortune; The Tribulations of a Chinaman
1880—The Steam House
1881—The Giant Raft
1882—The School for Robinsons; The Green Ray
1883—Keraban the Inflexible
Archipelago on Fire
1885—Mathias Sandorf; The Wreck of the Cynthia
1886—Clipper of the Clouds; A Lottery Ticket
1887—North Against the South; The Flight to France
1888—Adrift in the Pacific
1889—Family without a Name
1890—Caesar Cascabel
1891—Mistress Branican
1892—The Castle of the Carpathians
1893—Claudius Bombarnac; Foundling Mick
1894—The Adventures of Antifer
1895—Propeller Island
1896—For the Flag; Clovis Dardentor
1897—The Sphinx of the Icefields
1898—The Superb Orinoco
1899—The Eccentric's Will
1900—The Second Fatherland
1901—A Floating City; The Tales of Jean-Marie Cabidoulin
1902—The Kip Brothers
1903—The Traveling Scholarship
1904—Master of the World; A Drama in Livonie
1905—The Invasion of the Sea; Lighthouse on Top of the World



● Even before he was graduated from the U. of Kentucky, Sam Griffin, Jr. was "sold" on a job at Allison. His brother-in-law, who is in Allison aircraft engine test section, had told him about the many advantages and opportunities offered the young engineer with academic training like his.

So, when Sam left school in 1951 with his B.S. in Metallurgical Engineering, he came right to Allison where he is now Experimental Metallurgist in Transmissions Operations.

Allison, along with its aircraft engine activity and production of bearings and Diesel locomotive parts, is the world's largest manufacturer of Torqmatic Drives for heavy duty Ordnance and commercial vehicles and equipment. In all parts of the world, Torqmatic Drives are in use today in big trucks . . . tractors . . . cranes . . . shovels . . . tanks . . . drilling rigs . . . and scrapers.

After Engineering designs a part, such as—let's say—a spur gear, knowing what it must do, and the hardness required to do its specific job, it's up to the metallurgists to select a steel and heat treatment to meet the specifications. That's an important responsibility in the Allison Transmissions operations where as many as 700 different parts go through heat treat. Proper control here means less rework, and when the perfect surface is produced, the part is "ready to go," without grinding.

Sam has been doing pioneering work in heat treatment control with newly-installed equipment at Allison. He is shown above, as final tests are being made, at the panel of the Dew Point Recorder which checks the amount of moisture in heat treat furnaces. Twenty-four big furnaces are controlled by these two- six-station machines. It was his responsibility to see that the equipment was installed properly, and he also trains personnel in the proper use of the equipment.

The long range program at Allison offers unlimited opportunities to competent graduate engineers in various fields. Why not plan *early* for your engineering career at Allison.

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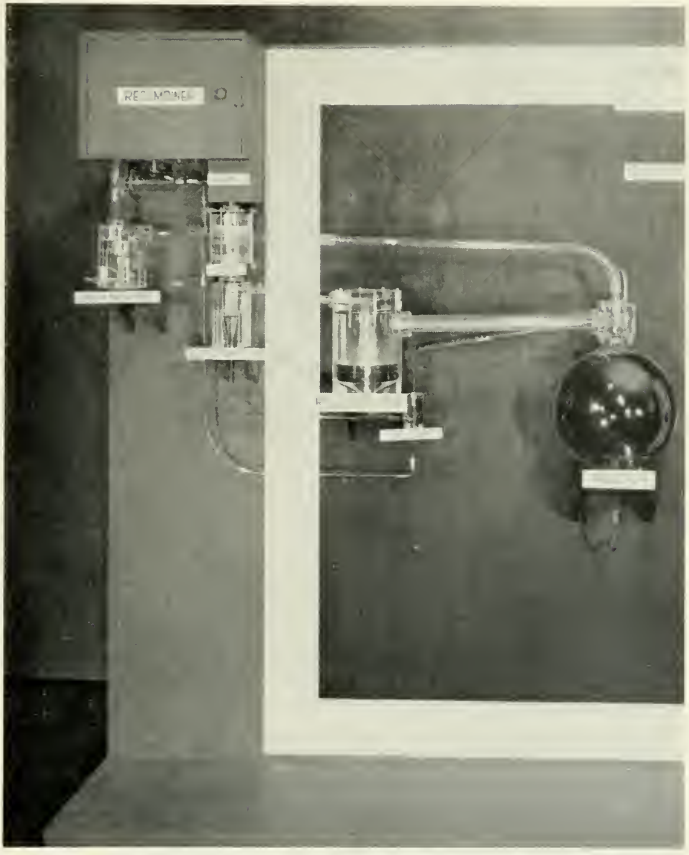
Percolating—

TEA KETTLE

by Dave Webster
Arch. E. '58



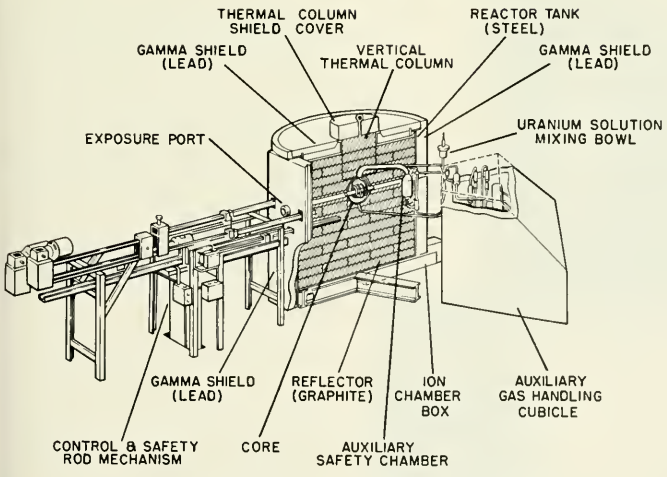
Testing the core component for the "Percolating Tea Kettle."

A powerful self contained "percolating tea kettle" atomic energy reactor for special nuclear research has been designed and built by North American Aviation for the Atomic Energy Commission. This new reactor is now in operation by the California Research and Development Company, Livermore, California, a contractor of the San Francisco Operations Office, U. S. Atomic Energy Commission. The reactor, which is being used for research, is the second in California.

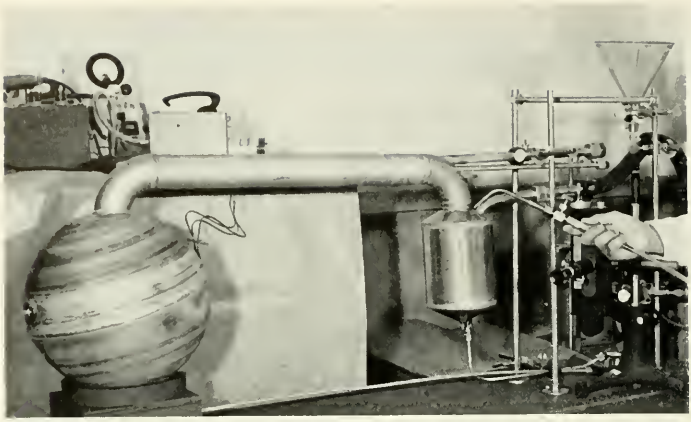
Developing 100 watts of power, the reactor is unique in that it is the largest unit of its type to operate with a closed cycle, or "self contained" system. The tea kettle or water boiler type reactor, one in which the fissionable uranium compound is contained in a water solution, is designed so all radioactive by-products of the fission process are retained in the unit instead of being exhausted and mixed with the open air, as in the case of other large reactors of this type. Radioactive by-products in the reactor are pressed inside the unit and returned to the reactor core. It is possible for the reactor to run for as long as 10 years without refueling.

Nuclear research scheduled for the new reactor will include fundamental studies as well as test work with various materials and components being studied for possible application to atomic energy equipment and processes.

The reactor will be "fueled" with uranyle sulfate, enriched in fissionable Uranium 25, in a water solution. About



A schematic diagram of the "Percolating Tea Kettle."



The new 100 watt atomic reactor.

four gallons of this material is housed in a steel sphere, one foot in diameter. A cylindrical stack of graphite bars, which surrounds the sphere, is used to reflect the neutrons produced by the fission process. The entire assembly is housed by a steel tank five feet in diameter and five feet high. Two control and two safety rods, made of cadmium and boron, run through the tank to the sphere. Because these rods have the ability to absorb neutrons, their presence near the sphere dampens the fission process. When the rods are withdrawn the activity of the Uranium 235 solution increases, producing neutrons and other nuclear radiations. Access holes leading through the tank to the sphere permit the bombardment of test samples by neutrons and other radiations. During ordinary operation, only the two control rods are used to start, stop, and regulate the fission process. The two safety rods are designed to automatically shut off the reaction if required.

Inherent characteristics of the design of a water boiler reactor make it virtually impossible for the fission process to "run away." If an uncontrolled fission occurs, the heat of the reaction in the water solution will stop the process before damage can be done. The safety rods can be used with the same effect. In addition to the natural safety feature and the safety rods, the reactor is equipped with an auxiliary safety chamber system as a further safeguard. A completely new development, the safety chamber provides a method of reducing the amount of fissionable material in the sphere to less than a "critical mass." This is accomplished by a percolating process. If fission gets beyond a certain rate, gas bubbling through the uranyl sulfate solution carries the material into the auxiliary safety chamber and away from the fission sphere, in the same manner that steam percolates water over coffee in the family coffee pot.

A number of designs have now been made for various purposes, including reactors for industrial, medical and academic research, and for the production of electric power. Other of the designs are being considered for industrial and medical organizations, whose work with the research reactors will speed the day when the present promise of greater application of atomic power to mankind will be a practical reality.

Frosh co-ed: "Mother, are there skyscrapers in heaven?"

Mother: "No, dear, it takes engineers to build skyscrapers."

* * *

Engineer: "Gee, but I'm thirsty."

Arts Frosh: "Wait a minute; I'll get you some water."

Engineer: "I said I'm thirsty, not dirty."

* * *

Physicist: "Glasses are getting to be a necessity with me."

Engineer: "Same here. I can't drink out of a bottle any more without beer dribbling on my chin."

* * *

Students are like blotters, they absorb everything but get it backwards.

* * *

"Do you believe in clubs for women?"

"Yes, if kindness fails."

* * *

Say it with flowers, say it with sweets,
Say it with kisses, say it with eats,
Say it with jewelry, say it with drink,
But never, oh never, say it with ink.

● There's a K&E slide rule for every purpose. Whether designed to meet the modest needs of the beginner or the exacting requirements of professionals, all K&E rules feature "built in" accuracy and reflect the skill and craftsmanship of America's most experienced slide rule manufacturer.

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PIER PILINGS

Der Flypaper

by Jim Piechocki, Aero. E. '55

At the Chicago Division of the University of Illinois, there exists an extensive engineering education program. The curricula included are Civil, Mechanical, Electrical, Architectural, Physics, Chemical, and Aeronautical. These constitute the major engineering branches of study. A quick glance back at that list and a possible second of thought along with it will reveal one feature which, to us, seems to occur too frequently—the last group, aeronautical, is always last. The common slang references which prevail throughout the engineering colleges are: CE's, ME's, Chem E's and so forth. When a student states that he is an Aero, an explanation usually follows.

Why? That is a question which has bothered a very select few for a long time. This small group of "select few" cannot seem to understand why this should be so at the UIC. And this select group has come up with some startling answers. The reason that this lethargic condition exists is none other than the fact that it is the Aeros themselves who are to blame. A sluggish condition results from a disturbance within. Self-inspection is the only answer, and after this is done, the time for action has come. The Aeros of UIC have come up with an answer—the spreading of that feeling of mutuality. This is the foundation up which the *Flypaper* is built.

The *Flypaper* is a publication which is centered around the aeronautical engineering student. It is printed *for him, with his aid,* for the most part, *by him.* It had an extremely humble beginning when on October 20, 1953, the first issue was released. The very first article of this one-page "attempt" stated its purpose:

> *". . . cooperation and unity of spirit — in one word — fellowship. Its nature — nontechnical. And therein lies the purpose of this paper. It is published only to fulfill a need — the promotion of fellowship which is so conspicuous by its absence. The ability to achieve success is in direct proportion to the intensity of fellowship, its warmth in thermal units remaining constant. . . ."*

Indeed, this humble beginning can be traced back to a day in September, when Ed Smith (now an editor), seated in the East End cafeteria with a few other Aeros, bluntly stated, "Let's put out a paper." And there it was, the very beginning. The name, *Flypaper*, was Jim Piechocki's brainstorm and was enthusiastically accepted amidst a fine spray of Pier coffee. Messrs. Smith, Shanahan, and Piechocki set out to convince their advisor, Mr. Fred Schroeder, of the worthiness of the project. Needless to say, Mr. Schroeder gave his immediate approval, and has been solidly behind the *Flypaper* ever since.

The reactions to the *Flypaper* have been many and varied, but very happily,

JIM PIECHOCKI

Jim Piechocki, an aeronautical engineering student, is a newcomer to the Technograph staff. He is the Chairman of the Engineering Council at U.I.C., and hopes to graduate in 1955.

they have been extremely encouraging to the editorial staff. The bold, black lettering of the title at the top of each first page has provoked such comments as, "Can I touch it?", "Is it still wet?", and "No thanks, we use DDT." The faculty of UIC have been very helpful in many ways. Not only are comments pouring in, but now they are submitting material. We cannot help but feel a deep sense of gratitude to Dean Trezise, who not only has given us every consideration possible, but also has enabled us to present his inspiring message to engineers via Page One of Issue No. 3. As if this were not enough, the title page of Issue No. 4 was adorned with the beautiful message of Mr. Sam M. Futral, assistant professor of M.E., and the praises for this article still are flowing in.

Now acting as the voice of the UIC

student branch of the IAS, the official Aero society, the *Flypaper* still is expanding. Its original staff of three co-editors swelled to four when the need of a staff artist arose. Vic Serafini, an Aero, came to the rescue and his beautiful illustrations are now the envy of the G.E. classes. At present, the staff has grown to what Aeros might consider a whooping size of seven persons. The three new additions are T. Anderson, J. Wargin, and B. Zientek. The new members handle NAS news, circulation, and printing, respectively.

The reproduction process is an interesting one. The ozalid process is used. Each Tuesday will find the staff plus other Aeros all hastening about in the photo lab, going through the motions of putting out the paper. These "ammonia kids" have deduced a rapid-fire system which has to be seen to be appreciated. The original issue was produced by typing up the copy on blue tracing paper; using this as the negative, the rest of the reproduction was the normal, run-of-the-mill Ozalid duplication. Then along came Bob Shanahan and his idea of typing up the copy on light velum which has been backed with carbon paper. This produces an extra-dark print which makes for ideal Ozalid reproduction. Quality was increased in staggering proportions. Although the method is by no means new, the *Flypaper* staff will always feel proud of "its own" process.

Aeros who are not on the staff are provided with an excellent opportunity to test their journalistic prowess. In fact, material now is flowing in at a rate which is keeping all editors on their toes. Recent contributions from Aeros have included everything from exposes on jet seaplanes to explanations of strap-on helicopters.

The future? Only time will tell, but the editors and staff express the mutual hope that someday, years from now, when we are all solidly established in industry, we will return to the UIC and pick up an interesting little paper called *The Flypaper*.

Engineering Prof.: "Why aren't you taking notes?"

Student: "I don't have to. I've got my father's."

* * *

Through the smoke and ozone fumes
the student slowly rises;
His hair is singed, his face is black,
his partner he dispises;
He shakes his head and says to him,
with words so softly spoken,
"The last thing that you said to me
was, 'Sure, the switch is open'."

* * *

CE: "I'm forgetting women!"

EE: "Me too. I'm for getting two or three and having a party."

"Frequent water drinking," said the specialist, "prevents you from becoming stiff at the joints."

"Yes," said the Engineer, "but some of the joints don't serve water!"

* * *

A man wandered into a tennis tournament the other day and sat down on the bench.

"Whose game?" he asked.

A shy young coed sitting next to him looked up hopefully.

"I am," she replied.

* * *

EE: "Well, what would you like to drink?"

Coed: "I guess I'll have champagne."

EE: "Well, guess again!"

* * *

Anyone who claims it is impossible to attain absolute zero hasn't taken a quiz in thermo lately.

* * *

During registration, a freshman listed as her denominational preference: "I like to be called Betty."

* * *

Two engineering students were taking calculus for the first time and while waiting for the instructor to arrive, they took a quick perusal through the book. One of them came across some formulas in the back of the book.

"Tell me," one asked his friend, "can you read this?"

"No, but if I had my flute with me, I could play it."

* * *

I call my gal a discontinuous function because she has no limits.

* * *

I still think that an intoxicated coed is a tight skirt.

* * *

And them there was the Arts student who let his EE roommate fix him up for a date with Allis-Chalmers.

* * *

Some girls complained to the dean of women that the boys in the fraternity house next door never closed their blinds and that it embarrassed the girls.

When the dean went to the room of the particular girl who had made the complaint, she looked out the window and said, "Why, I can't see in their window from here."

The girl said, "Oh, you have to stand on the chair."

* * *

"What kind of dress did your girl have on last night?"

"I don't remember all the details, but I do know the dress was checked."

"Boy! That must have been some party."

Successful designs must have low manufacturing costs.

HOW TO CUT COSTS WITH WELDED PRODUCT DESIGN

LOW manufacturing costs are a "must" in today's product planing. As a result, every engineer must know, above all, how to eliminate needless cost in machine designs.

First consideration in designing machinery must be the material used. Steel is three times stronger, twice as rigid as cast iron, yet costs only a third of the price of gray iron.

That's why machine parts built with welded steel designs often cost 50% less to produce.

Fig. 1. Original construction *of gear case cover weighed 66 pounds . . . required milling of bottom edge for oil-tight seal with gear case.*

Fig. 2. Steel designed gear case *cover now used weighs only 10 pounds . . . costs half as much to produce. Fabricated entirely in the manufacturer's own shop by arc welding.*

Keep in step with the rapid progress in manufacturing with arc welding. Latest design developments are available in bulletins and handbooks that guide the engineering student. Write

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The most diversified development program in Lockheed's history is under way—and it is still growing. The many types of aircraft now in development indicate Lockheed's production in the future will be as varied as it is today—and has been in the past.

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BURBANK, CALIFORNIA

A Report on the . . .

1953 Engineering Open House

by Hal Harper, Secretary-Treasurer, 1953 Engineering Open House

GEORGE HUNT

Chairman 1954 Engineering Open House

George Hunt, chairman of this year's Engineering Open House, has been in many activities, both here and at Navy Pier. He has been a member of A.I.E.E. for three and a half years and is the present secretary of this society. He is also a member of Pershing Rifles and the Military Council, having joined

GEORGE HUNT

both organizations three years ago. Also he belongs to the Engineering Council, DeMolay, and Sigma Phi Delta of which he is this year's intra-mural manager. While at Navy Pier, he was catcher on the baseball team. He is also a distinguished military student in the R.O.T.C.

A Chicagoan, George graduated from Hirsch High School where he belonged to the student senate and national honor society and was chief fire marshal.

Now a Senior in Electrical Engineering, George transferred from Navy Pier in his junior year. He has maintained a 3.8 average and after graduation hopes to work in Illinois, preferably Chicago, in the field of public service of motor apparatus and control.

On March 27 and 28 of last year the Engineering College of the University of Illinois once again opened its doors to an inspection by the general public. Such an inspection, called the Engineering Open House, has been held many times in previous years and, due to the continued success of these programs, will be held in future years.

It is felt that by attending these Open Houses visitors to our campus will not only learn something of the way an engineering college operates but also will see some of the spirit and cooperation that exists between the students and faculty of the University of Illinois. The entire engineering campus is opened to inspection, and it is hoped that such an inspection will aid students considering an engineering education in selecting a university and will aid undecided students in selecting a field of major study. The better understanding of the operations of this college should help the people of the state to better understand the importance of their continued suport of a state university.

If such an Open House were poorly planned the net result would directly oppose the desired result. Instead of gaining a favorable impression of the College of Engineering and realizing that it is something in which the State of Illinois should take pride the impression would be negative or, at best, indistinct. Therefore the planning for the 1953 Engineering Open House began shortly after the start of the fall semester of the 1952-53 school term. One of the first jobs to be done after the various committees necessary to a successful Open House had been selected was the job of publicity. Letters were sent to the principals of every high school in the state telling them that there was to be an Engineering Open House and inviting anyone interested to attend. The first such letter was mailed November 10, 1952. In subsequent letters the principals were informed of the time schedule, room facilities, parking facilities, and other information pertaining to their visit to our campus. The large numbers of high school students attending the Open House is witness enough of the success of this program.

In addition to the work done on individual displays by the various engineering departments at the University it was necessary to have a central committee in charge of physical arrangements to coordinate these displays. Without arrangements for bus service to the outlying displays, room reservations for

Testing of metals with a Charpy impact machine in the Metallurgy Laboratary.

Students demonstrating the pouring of aluminum castings in the University of Illinois Foundry.

weekend guests, lunch stands, signs, and a multitude of other special effects the Engineering Open House could never have been run as smoothly as it actually was. There is little doubt that services like those mentioned here were given little or no thought by the majority of the guests at the Open House, but nevertheless the work done on these arrangements was invaluable to its success.

So that programs for the Engineering Open House could be circulated as part of the publicity campaign it was necessary that they be printed early in the planning period. This forced departments of the College of Engineering to not only have a general plan for their displays in the Open House but to know just what to display several months before the Open House was to take place. The final rewrite of all articles for the program was turned in to the program committee early in December for the Open House the following March. The various departments did a fine job of advance planning, and each individual display contributed in some way to the over-all success of the Engineering Open House as a whole. The fine cooperation between students and faculty of every department and the time so unselfishly contributed by both made the Open House possible.

In addition to displaying physical equipment and educational facilities each department made an effort to "put on a show" for the visitors to the campus. An effort was made to display the things that would hold the most interest for the greatest number of people. The Mechanical Engineering Department displayed their foundry during the pouring of cast iron, aluminum, and brass. It was possible to follow the manufacture of small engines by first seeing the parts cast in the foundry and then seeing them machined and assembled in the machine tool laboratory. Other exhibits by the Mechanical Engineering Department were the educational unit power plant, air conditioning test setup, welding, and automotive engine tests. The Electrical Engineering Department, on the other hand, displayed apparatus showing some of the less known properties of electronics. Among their equipment were such things as eddy current heating, artificial lightning, and radar in operation. The Theoretical and Applied Mechanics Department displayed the testing of a large concrete cylinder in compression because of the explosive nature of the failure. By planning exhibits in a manner similar to that of these departments the interest of the general public was captured and held throughout the entire Engineering Open House.

The work done by the various committees of the Engineering Open House can hardly be overemphasized. The central committee, made up of the chairmen of the special committees and under the chairmanship of the general chairman, planned the over-all policies of the Open House and, together with an executive committee made up of student representatives from each department of the College of Engineering, coordinated the work of these departments. The faculty advisors, under the chairmanship of Prof. J. E. Williams of Electrical Engineering, worked with the student representatives from their departments on initial planning and final execution of plans for the Engineering Open House.

It is hoped that every Engineering Open House in the future will be favored with the same spirit and cooperation that favored the last one. It is felt that with such spirit each Open House will be as successful as this one.

The sport car on display in the Internal Combustion Laboratory of the M. E. Department was one of the many attractions of the 1953 Engineering Open House.

BOOK REVIEWS

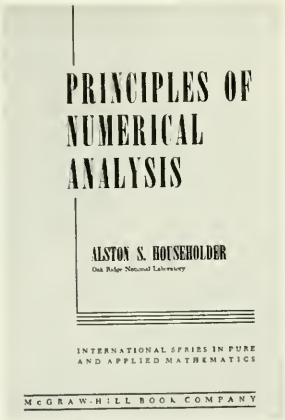
by Paul E. LaViolette, E.E. '55

PRINCIPALS OF NUMERICAL ANALYSIS

by ALSTON S. HOUSEHOLDER
McGraw-Hill, $6.00

Another addition to McGraw-Hill's International Series of Pure and Applied Mathematics is this book by Alston S. Householder, Head of the Mathematics Panel at Oak Ridge National Laboratory. Dr. Householder organized the computing group which, in December of 1948, became known as the Mathematics Panel providing mathematical, statistical, and computing services for the entire Oak Ridge Laboratory.

Written as a unified presentation of the mathematical principles underlying most computing methods, "Principles" is designed more for the senior-graduate courses or for directors or mathematicians of computing groups who wish to invent, improve or evaluate techniques than for the casual mathematical minded browser. The book is directed toward digital computation and techniques for making estimates of errors are indicated whenever possible. Functional equations are not discussed, but emphasis is placed upon the methods of


PRINCIPLES OF NUMERICAL ANALYSIS
ALSTON S. HOUSEHOLDER
Oak Ridge National Laboratory
INTERNATIONAL SERIES IN PURE AND APPLIED MATHEMATICS
McGRAW-HILL BOOK COMPANY

solving the finite systems, and performing the interpolations which are required in the digital solution of functional equations. All are approached with a strictly theoretical approach.

Matrix applications, inversion and determination of eigen values and vectors as well as a brief discussion of the Monte Carlo method are discussed and correlated with existing old techniques to form a useful help as a background for those seeking to devise and evaluate routines for numerical computations.

With a view to making the book useful to the reader who has not advanced beyond calculus, the author develops the necessary theory of matrices and determinants and the theory of equations and to presuppose only as much of the theory of complex variables as such a reader might have.

NEW WORLD OF THE MIND

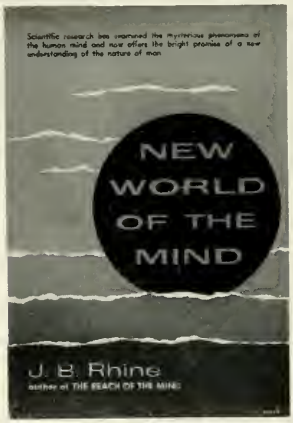
by J. B. RHINE
Sloan & Assoc., $3.75

It happened during World War II. A woman dreamed that her son was being crushed by a palm tree which fell across his tent. Terrified, she called his name aloud and woke up. On a Pacific Island several thousand miles away, her son, thinking he heard his mother's voice, rushed outside his tent to see where it might be coming from. Just then a tree crashed into his tent, directly across the cot where he had been sleeping. He wrote his mother of the event, convinced that his dream saved his life. Not until later did he know that she had had a similar dream.

At another time, an army sergeant from Kokomo, Indiana, on being transferred to Augusta, Georgia, a distance of 700 miles, shipped his large, yellow tomcat in an express car to Augusta. Soon after it arrived in Georgia, the cat left the sergeant and in about three weeks found its way back to the farm at Kokomo, where it was easily identified by family and friends.

These are only two examples of extra-sensory perception (ESP) cited by Dr. J .B. Rhine in his latest book, "New World of the Mind." Opening a new field to scientific research, Dr. Rhine takes the age old mysteries of telepathy, clairvoyance, precognition, and the influence of mind over matter, out of the realm of superstition and places them in the domain of science. "Para-psychology" is the technical word embracing the whole subject. In his para-psychology laboratory at Duke University, Dr. Rhine and his associates have run thousands of tests to establish the fact that ESP exists. He has succeeded in doing this and his methods have now been recognized even by those who formerly scoffed at ESP. Dr. Rhine, himself, however, is the first to admit that only the groundwork has been established. What lies ahead presents a challenge to all thinking persons—a new world of the mind that can conceivably affect every aspect of our lives from science to religion.

Psychic experiences are nothing new to the world. What is new, however, is Dr. Rhine's approach to studying these psychic phenomena. Realizing that the measurements afforded by the known physical sciences were not sufficient to measure ESP experiments, Dr. Rhine set about constructing his own laboratory tests under rigid control conditions. Perhaps the best known test which he and his staff devised was a set of cards to test telepathy. The subject was seated on one side of a screen and the "sender" on the other. The subject was then instructed to write down the symbol which appeared every-


Scientific research has examined the mysterious phenomena of the human mind and now offers the bright promise of a new understanding of the nature of man
NEW WORLD OF THE MIND
J. B. Rhine
author of THE REACH OF THE MIND

time a card was turned over. Thousands of such tests showed that chance alone could not have accounted for the scores. Seeking still more perfect experimental conditions, Dr. Rhine increased the distance between the subject and the sender, even to the point of placing them in different buildings. The scores again ruled out the possibility of chance.

Similar restrictions were placed on experiments in other fields of ESP, so that Dr. Rhine gives proof to his conclusions by the results of his laboratory tests. After studying the psychic factor in humans for many years, Dr. Rhine and his staff became interested in psi in animals. After collecting numerous accounts of the homing of pets, such as the case of the yellow cat, (known as psi-trailing), Dr. Rhine became convinced that animals are capable of psi, and this is one of the projects now under study.

Dr. Rhine's book will be read with interest by those who approach the problem from a scientific point of view. Those who expect a journal of psychic experiences will be disappointed, for Dr. Rhine uses these only as illustrations. He reviews what has been done up to now, the present stages of the research, and the problems and challenges that lie ahead.

There's plenty of "head room" for you at Boeing

If you are a senior in any field of engineering, it would be advisable to consider the advantages of a career at Boeing after you graduate.

Boeing, for instance, makes a policy of "promoting from within." Regular merit reviews give you steady opportunity and recognition. And in a company with a growth record like Boeing's, there's always plenty of "head room" to move into.

Another advantage at Boeing is career stability. Boeing has grown practically continuously during its 37 years of operation. Today Boeing actually employs more engineers than even at the peak of World War II.

Still another Boeing advantage is the variety of experience and contacts available to you here. Boeing is constantly alert to new materials and techniques, and approaches them without limitations. Extensive subcontracting and major procurement programs — all directed by engineers — give you contacts with a cross section of American industry. Aviation, in fact, is unique in its variety and breadth of application — from applied research to production design, all going on at once.

At Boeing you'd work in Seattle, Washington, or Wichita, Kansas — two fresh, modern cities with a wide variety of recreational facilities, fine shopping and residential districts, and universities which provide excellent graduate study courses. The company will arrange a reduced work week to permit time for this study and will reimburse tuition upon successful completion of each quarter's work.

There are openings in *all* branches of engineering (mechanical, civil, electrical, aeronautical, and related fields) for DESIGN, PRODUCTION AND RESEARCH. Also for servo-mechanism and electronics designers and analysts, and physicists and mathematicians with advanced degrees.

For further information, consult your PLACEMENT OFFICE, or write

JOHN C. SANDERS, Staff Engineer — Personnel
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Where, O where, did that formulo go?

Comes

Big brain session in C.E.H.

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Klepicka)

"We are marching for 'Dear Old Illini'."

'Twas the night before finals.

Precision, high-speed winding equipment for IRC elements

IRC WINDING SKILL OFFERS REALISTIC SAVINGS TO INDUSTRY

BASIC TECHNIQUE

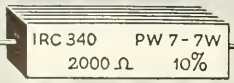
Wire element is uniformly and tightly wound on an insulated core. Axial leads or other terminations are secured to element by automatic machinery. Insulated housing may be used or omitted.

SPECIFIC EXAMPLES

IRC Type AW Wire Wound Resistors

IRC Type BW Insulated Wire Wound Resistors

IRC 4-watt Insulated Power Wire Wounds



IRC 7 and 10 watt Power Wire Wounds

. . . another reason why engineers specify IRC Resistors

Savings in the initial cost and assembly of component parts are an increasingly important factor to electronic engineers. That's why they depend upon IRC for their resistor requirements. IRC's mastery of winding wire elements—dating back more than 25 years—today provides a wide variety of unique units that offer realistic possibilities for savings.

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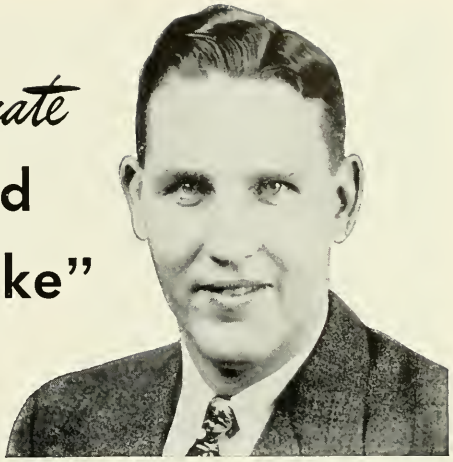
"Allis-Chalmers Graduate Training Course Helped Me Find the Work I Like"



says HUGH C. SELLS,
Syracuse University, BS—1942
and now Manager, Knoxville District Office

"I guess I was like many graduating engineers. I didn't really know what I wanted to do. When the Allis-Chalmers representative visited the campus, and described their Graduate Training Course, it sounded like the type of postgraduate training I really needed.

"What appealed to me then—and still does—is the broadness of the program. Here is a company filling a unique spot in industry. It makes important, specialized equipment for almost any industry you can name."

Wide Choice of Activity

"It's like a big department store for industry. But that isn't all! In addition, it offers a wide choice of activity within each of these many product groups . . . whether it be sales, design, research or production.

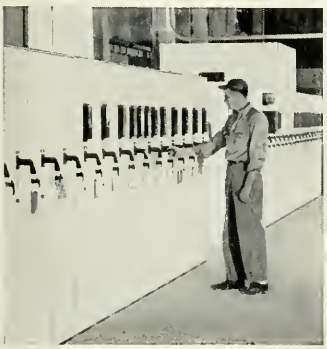
"After getting the broad look at industry the program offers, my interest began centering on Service and Erection of large equipment. This led me into many departments of the company, and I learned about everything from steam turbines to sifters for flour mills."

Valuable Background

"The transition from service to sales was natural. The background of service and erection work proved very valuable.

"So you see, whether you think you know what you want to do or not, the Allis-Chalmers Graduate Training Course is so flexible, so broad in its scope, you have a real chance to find yourself. Best of all, you don't have to waste time doing it."

ELECTRONICS—Modern way to dry sand cores is with Allis-Chalmers *Foundromatic* Sand Core dryer. Revolutionary new process dries cores in minutes instead of hours.



POWER—Neat, compact and safe switchgear installation is big improvement over open framework and knife switches in older installations.

Facts You Should Know About the Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

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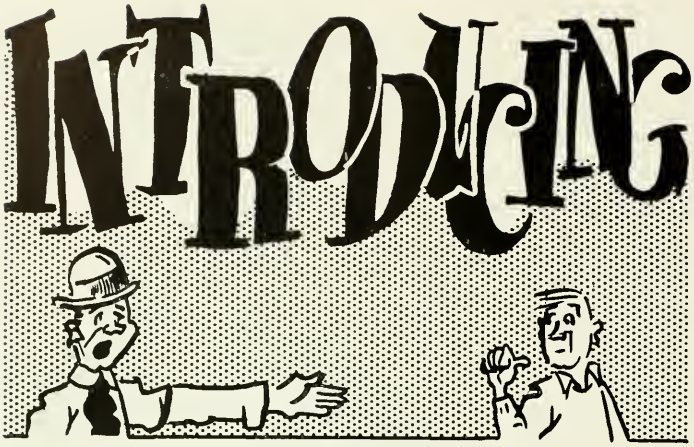


by Charles Runyan, E.E. '57, and Frank Krbec, Gen. E. '57

GLENN ZIEMAN

If you are looking for a busy Illini engineer, just visit the Sigma Phi Delta house and ask for Glenn Zieman. You will be lucky if you find Glenn, a junior in mechanical engineering at home, for he divides his time between studying, acting as chairman of the St. Pat's Ball committee, and the Engineering Council.

Glenn came here from Lake Forest

GLENN ZIEMAN

High, where he coached and ran on the track team. At Illinois he is fostering his interest in athletics by playing an occasional game of tennis. On campus, Glenn is a member of several professional groups, including ASME, the Rocket Society and the advanced ROTC.

Some plans for this year's St. Pat's Ball were revealed by Glenn. It will be held at George Huff Gym on March 13, 1954, and will feature an Ugly Man contest, selection of the Knights of St. Pat, and displays by professional societies.

After Uncle Sam lets him go, Glenn will seek an administrative position in mechanical engineering. Asked why he chose engineering as a career, Glenn replied that he has been interested in science "from the cradle up;" maybe his hobby of tinkering with alarm clocks influenced his decision.

DR. JOHN D. RYDER

Doctor John D. Ryder, head of the Electrical Engineering department, came to Illinois from Iowa State College. He was born in Columbus, Ohio, in 1907. He received his B.E.E. degree in 1928, and a year later, his M.S. degree from Ohio State University. He then obtained a position with General Electric where he specialized in electronics work and the development of the thyratrons.

In 1931 Dr. Ryder joined the Bailey Meter Company of Cleveland, Ohio, as supervisor of the electrical and electronic section of the Research laboratory. He holds 24 patents in his work, covering temperature recording and automatic control applications of electronics. Equipment now being manufactured under these patents include the Bailey "Pyratron" group of devices and the General Electric and Weston photoelectric potentiometers.

In 1941 Dr. Ryder became an assistant professor of electrical engineering at Iowa State College. He continued at that position until 1944, when he became professor of electrical engineering in charge of electronics courses. That same year he was awarded his Ph.D. in electrical engineering by Iowa State. He became assistant director of Iowa Engineering Experimental Station in 1947. In September of 1949 he assumed his present position at Illinois.

Dr. Ryder is the author of two textbooks, *Electronic Engineering Principles* (Prentice-Hall, Inc.) and *Network Lines and Fields* (Prentice-Hall, Inc.); the former is being used in the course, E.E. 340. He has written many other

DR. JOHN D. RYDER

authoritive papers on D. C. and A. C. motors, vacuum tube voltmeters, network analyzers, and electronics.

Dr. Ryder is a member of electronics committee, education committee, and all of the American Institute of Electrical Engineers. He is also a member of the Adavncement of Science, and numerous honor fraternities, some of which are Tau Beta Pi, Eta Kappa Nu, and Sigma Xi.

Professor Ryder was married in 1933. He has a 16 year old daughter, Barbara, and a son nicknamed "Mac", 13 years old. Besides his children Dr. Ryder has an interesting hobby, color photography, and he has several thousand Kodachrome photographs of western national parks. He is also a "ham" radio operator of his own station WOVDE.

The combination of education and intrest in activity marks Dr. Ryder as one of the more distinguished personalities on the engineering campus.

LISLE A. ROSE

In the year 1947 amidst the scramble for education by many World War II veterans the University of Illinois ran up against some tough problems. Additional men were needed for admin-

36 YEARS OF NEW IDEAS

To MAINTAIN a top position in the aircraft industry for more than 36 years requires the engineering of new designs through the application of engineering experience plus imaginative thinking. Chance Vought Aircraft has offered the opportunity for such a career since the day of its founding in 1917 when it began the design of the VE-7, a two-seated biplane which was redesigned for the Navy as the VE-9.

During the past 36 years young engineers and scientists have been an important source of these new ideas. Today, more so than ever before, many interesting career opportunities are available at Chance Vought as the company designs the latest versions of the F7U-3 Cutlass, the "Regulus" guided missile and other high speed fighter aircraft projects.

The achievements of the past 36 years at Chance Vought, great as they have been, offer little means of evaluating fully the potential of aviation's future. If you are interested in a position with an unlimited future, a position with the constant responsibility of evaluating and applying new ideas, if you are interested in working for a company with a wealth of experience in its line and yet ambitious to create the latest designs in its field, investigate the employment opportunities at Chance Vought.

Engineering and scientific graduates are invited to contact their Placement Officer to arrange for a personal interview when the Chance Vought Engineering Personnel Representative visits on campus.

CHANCE VOUGHT AIRCRAFT

INCORPORATED

Dallas Texas

istrative posts in all colleges and among them came Professor Rose, as director of engineering informations and publications.

With a firm background in education he has ably filled the job of a public relations administrator in engineering. Professor Rose's experience goes back

LISLE A. ROSE

twenty-eight years, to graduation from the University of Chicago. There he completed his formal study with a Doctor's degree in literature and a nod towards American History. His interests soon focused themselves on the engineering profession. He became a liaison man who promoted information on problems of engineering education, and has assisted in planning better programs for young engineers. Professor Rose believes in a well-rounded education which would include more of the humanities and social science courses. He realizes the great need for this knowledge in the world of today and the success of Illinois engineers proves his point.

Professor Rose has held teaching positions at Culver Miliatry Academy, the University of Chicago, and Michigan Tech, where he became a department head in 1939 and public relations director in 1945. He's written several publications on the subject of engineering education and is credited with many reports. His fields also include economics and government, and problems which influence their roles in history. History is one of his favorite subjects. He probably knows more about the civil war than did Ulysses Grant himself.

Professor Rose holds the local chairmanship for the 62nd annual meeting of the Society for Engineering Eduction which is holding its convention here in 1954. He is a Fellow of the Royal Society of Arts, Manufactures, and Commerce. In general, however, Professor Rose concentrates his activity and ability from his office in the C. E. building. From there he cooperates with other staff and faculty members on new educational projects which help mold the student of today into the engineer of tomorrow.

Confucius says, "Modern women putting up such a false front, man never knows what he is up against."

* * *

Ken: "What did the usherette say when her strap broke?"

Ray (a non engineering student) "I dunno."

Ken: "I have two down in front."

"Of course I love you, Tom," and she took off her stockings. "We will have the sweetest little bungalow," and she took off her sports sweater. "We will have a lot of little flower beds," and she took off her skirt. "Tom, dear, why can't we be married in the spring when all the world is filled with laughter?" and she took off her camisole. "If you prefer the fall I prefer it too, because we are as one, sweetheart," and she took off her petticoat. "Tom, dear, tell me once more that you love me," and she removed her last vestige of clothing. "Tom, honey, I better say goodnight for I have to get up early in the morning." And she hung up the receiver.

* * *

Fie upon thee, little man
With thy slide rule in hand:
Seated at your work all day
While your roommates drink and play:
Throw away your graphs and charts
Now's the time to switch to arts.

* * *

When Sue returned from a ride, her mother noticed that one of her shoes was muddy.

"Why is your right shoe muddy and and not your left?" she asked.

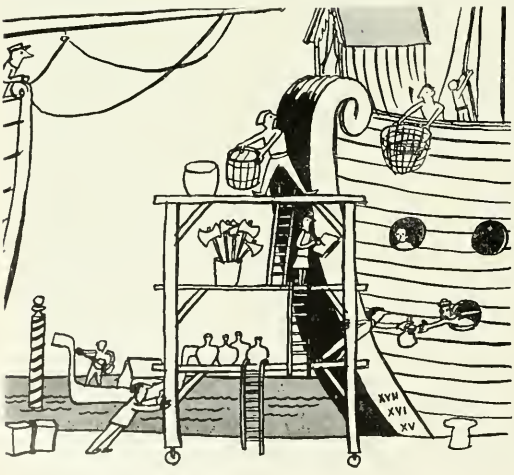
"I changed my mind," Sue answered.

* * *

They say that Professor K. Cycle gives a well-rounded course in communications. Everything that he doesn't give in class during the semester he includes on the final examination.

* * *

The man didn't say a word when he ran over his cat with a steam roller. Just stood there with a long puss.



What the devil did he want in that galley.

How Venice Built Liberty Ships In the 15th Century

Venice, the world's first modern state, apparently created the first true assembly line.

Throughout the 15th and 16th centuries, a Venetian water basin called the Arsenal, which employed 16,000 men and manufactured everything from cannon to nails, was the world's largest industrial plant. There Venice built a standardized trading vessel which could be quickly converted into a galley of war.

When finished, the galley was towed slowly down a canal, and, as it passed, workmen reached out of windows on either side and loaded on its equipment. When the vessel reached the end of the street, everything necessary was on board, including cordage, oars, armament, food, and a full complement of men.

"In this manner," wrote a Spanish visitor in 1436, "there came out ten galleys fully armed, between the hours of three and nine." In 1570, during the war with the Turks, the Arsenal turned out a hundred fully outfitted galleys in a hundred days.

Role of the Engineer in the Navy

by Joe Endres, Chem. '54

Since the advent of the industrial revolution, the field of engineering and the natural sciences relating to engineering have expanded considerably. The broad expansion of industry has necessitated the subsequent specialization by the engineer. The engineer must still acquire a good knowledge of the basic engineering principles, but then usually concentrates upon a particular phase in his field of engineering.

Let us say for example that one is a civil engineer. A civil engineer may option in such courses as structural, or sanitary or possibly railway engineering. The basic principles for each of these options is the same, but since there is a particular amount of specialized training needed in each case, each is given a special name. However, each of the above mentioned options is basically related to the general field of civil engineering. Thus, it is relatively easy for a civil engineer, or any engineer as a matter of fact, to shift from one job to another.

The skilled and semiskilled worker on the other hand finds it difficult to shift from one job to another. A worker has developed a special skill which is particular for his type of job. He is therefore able to do his job better than anyone else. This is the usual arrangement between the worker and the engineer found in industry.

So, too, the military forces of today have realized the advantages of training its personnel in a manner described above. Such a system is widely employed in the Navy of today. The enlisted men in the Navy are trained for a particular type of job or duty, while the line officers are given a general training course. Thus the officer is capable of taking over and coordinating any type of job.

The Navy has established Naval Reserve Officer Training Units at fifty-two universities and colleges throughout the country for the purpose of training line officers. The line officer, whether he be an engineer or sociology major, is required to complete certain courses in Naval History, Ordnance and Gunnery, Navigation and Aerology, Naval Machinery, Damage Control and Military Law.

To augment the experience and training of the potential officer, each candidate is required to complete three summer training cruises during his four years at college.

When a midshipman first boards a ship for his summer cruise he is surprised at the compactness of the machinery and equipment. After his first tour through the ship, the midshipman sees that the naval warship is highly mechanized. He sees that the operation and maintenance of the ship requires that every man do his job correctly. The heaviest burden falls upon the Engineering Department and the men assigned to it. Since we are particularly interested in engineering, let us look at the organization of the engineering department aboard a typical ship.

The head of the department is the engineering officer. This officer has cognizance over all the men and equipment assigned to his department. The department is broken down into divisions, with a line officer at the head of each of the divisions. Each division is made up of enlisted men trained for a particular job, such as boilerman, machinist mate or electrician's mate. The engineering divisions operate and maintain all the equipment assigned to them, and any other equipment assigned to some other department which does not have any men qualified to operate the equipment. This is but a superficial breakdown of the engineering department and the duties assigned to it.

During the cruise the midshipman is assigned to the engineering department for two or three weeks. During this period, the midshipman stands watches with the enlisted men and the officers.

—Courtesy the Iowa Transit

He helps and watches the enlisted men in their work. Every opportunity is given the midshipman to actually operate and see the equipment used on board a ship. Thus, when the "middie" gets back to his unit, and studies in detail the operation of the various pieces of equipment, he gets a better understanding of the equipment.

There are numerous lectures given by the officers on such general subjects as special fire control equipment, electrical systems or boiler operation.

The midshipman also is exposed to the administrative work involved in the proper operation of the department. The Navy requires that a complete record be kept of every piece of equipment and machinery assigned to the department. A record of any adjustments, replacements or alterations is kept in the history of a piece of equipment. If the equipment has any peculiarities or requires any special adjustment, this too is noted in these records.

After completing his cruise the midshipman returns to college and completes his work. Thus, during his four years at school the student receives training in his chosen field plus the theoretical and practical training required by the Navy.

When the midshipman finishes his schooling he receives a commission as an ensign, and is assigned to a ship. Likely as not he will be assigned to the engineering department. The officer now has to learn how to handle men, and to perform the necessary administrative duties required of an officer. Because of the complexity of naval warfare and ship board operation, the actual operation of the ship and its equipment is entrusted to the enlisted men. The officers act as a supervisory group. However, the officer still is required to know the operation of the equipment. He will be responsible to see that the proper orders are given.

Thus the engineer in the Navy does two jobs. He uses his technical knowledge to supervise the operation of his men and the equipment that they operate. The officer-engineer also has many administrative and executive duties to perform.

The officer who does not wish to stay in the services can use the technical and administrative training that he has received in a civilian job. The engineer has been able to use his engineering training, has learned leadership, and has learned some administrative procedure. Probably the most important thing that he has learned in the Navy is leadership, something that a man in college has little chance to develop.

A philosophizing friend remarks that a man never knows whether he likes bathing beauties until he's bathed one.

To the **E.E.**
or **Physics Graduate**
with experience in
Radar
or **Electronics**

Here's a **new kind** *of career*

Hughes Research and Development Laboratories are engaged in a continuing program for design and manufacture of advanced radar and fire control systems in military all-weather fighters and interceptors.

YOU WILL serve as technical advisor in the field to companies and government agencies using Hughes equipment.

TO BROADEN your field of experience in radar and electronics you will receive additional training at full pay in the Hughes Laboratories to become thoroughly familiar with Hughes radar and fire control equipment.

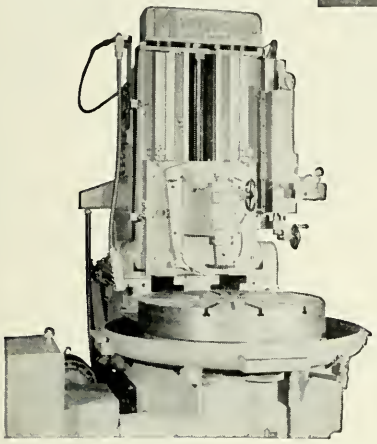
AFTER TRAINING you will be the Hughes representative at a company where our equipment is installed; or you will direct operation of Hughes equipment at a military base.

THE GREATEST advancements in electronics are being made in this sphere because of military emphasis. Men now under 35 years of age will find this activity can fit them for future application of highly advanced electronic equipment.

Hughes Field Engineer G. R. Chambers instructs a group of Air Force technicians in the operation and the maintenance of Hughes equipment.

Hughes | **Research and Development Laboratories**
SCIENTIFIC AND ENGINEERING STAFF
Culver City, Los Angeles County, Calif.

Another page for **YOUR BEARING NOTEBOOK**

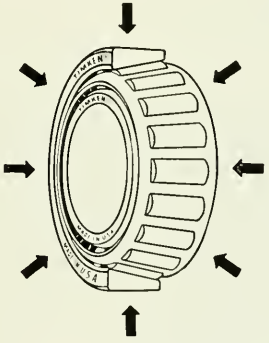


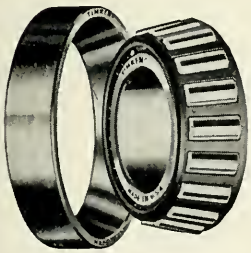
How engineers designed .0002" accuracy into a gear shaver table

To get the high accuracy necessary in gear shaving operations, engineers had to have extreme spindle rigidity. If the spindle could be held rigid, it would eliminate chatter and vibration. To get this rigidity, engineers mounted the table spindle of this gear shaver on Timken® tapered roller bearings. The result—a measurement of this gear shaver's accuracy showed a maximum runout of .0002", exceptional in view of the fact that these bearings have 17⅜" and 16⅜" bores.

How TIMKEN® bearings hold spindles in rigid alignment

Deflection is minimized, end-play and chatter eliminated because the tapered construction of Timken bearings enables them to take *any* combination of radial and thrust loads. Line contact between rollers and races gives spindles wide support for extra rigidity.



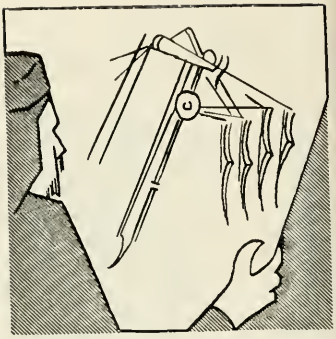


TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Want to learn more about bearings or job opportunities?

Many of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⓪ AND THRUST —⓪— LOADS OR ANY COMBINATION ✳



Leonardo da Vinci

by Donna Rudig, E. Physics, '57

Leonard da Vinci, considered by many to be one of the greatest geniuses of all time, had a versatile mind which explored every type of art and almost all of the sciences. He is considered to have been an artist, statesman, architect, engineer, inventor, sculptor, musician, natural philosopher, statistician, mathematician, and physiologist.

Leonardo was born in the town of Vinci, in Tuscany, France, as the son of Ser Piero da Vinci, a Florentine lawyer. His first years of school were not as enjoyable to the young boy as was walking in the fields and hills surrounding town. Often in those early years he preferred being alone in the hills painting scenes, rather than playing with the boys of his age. As he grew older he became more interested in school, and was soon solving many difficult mathematical and engineering problems which puzzled his teachers. When do Vinci was eighteen, the senior da Vinci became so enthusiastic over the boy's artistic ability, that he sent him to study under the famous Florentine artist, Andrea del Verrocchio.

Leonardo Da Vinci (1452-1519).

The years between 1482-1499 were some of the most active and glorious ones of Leonardo's life. Having by this time reached fame as an artist and scientist, Leonardo was invited to Milan, at the invitation of the Duke, Ludovico Sforza. While there, he invented arms and machinery for use in war. These inventions included a mowing machine (a vehicle surrounded by scythes to cut down enemy foot soldiers and horses, and motivated by a horse located in the middle of the contraption) and an armored tank. But because most of his inventions were too advanced for that era, he turned his interests elsewhere. He made plans and models of the Milan cathedral, then supervised the building of it, acted as director of pageants and masques, improved the neighborhood canals and irrigation and produced a colossal equestrian statue of the father of the Duke. In 1496, in the nearby Dominician convent of Santa Maria delle Grazia, he painted the world famous picture of the "Last Supper." During these years he extended his research of architectural difficulties and physics. He also studied statistics, dynamics, human and animal anatomy, geometry, Phenomena of light and shade, the science and art of bronze casting on a large scale, and better methods of city sanitation. In 1499 he made studies of the tides of the Exerxine and Caspian Seas, and submitted drawings and models for canalization and control of the waters of Aron.

In 1500 he returned to Florence to the service of Cesare Borgia, Duke of Romahna, as an architect and engineer. During this time he painted the picture

Leonardo da Vinci's Flying Machine

In the time of Leonardo da Vinci, men had to take great risks to further the progress of science. The attempt at flight pictured here was made in 1505—with near-fatal results.

—Courtesy International Business Machines

of "Mona Lisa." In the year 1514 Pope Leo X invited Leonardo to Rome, but friends of Michelangelo and Raphael prejudiced the Pope against da Vinci, who finding himself not welcome, returned to France in 1515.

Back in France he planned canals and moats, and made drawings and maps of the territory of Naremma, Tuscany, and Umnia between the Apennines and the Tyrrhene Sea. He planned the restoration of the palace of Frederic II and designed a new palace to be built at Amboise.

Leonardo was the first painter to recognize the play of light and shade upon objects, and was especially attracted to unaccustomed appearances, such as strange shapes of hills and rocks, or rare plants and animals. He studied optics, persepective, libration, proportion, and muscular control, for his insatiable mind was always trying to find the laws and causes which nature hid. His architectural and engineering projects amazed even his fellow-citizens of Alberti and Brunelleschi. He was Watt's precursor; only he intended steam to project a missile from a cannon. He devised a sort of snorkel which would allow a person to remain submerged underwater for long periods of time. An airplane which he designed included a board on which the operator lay and operated oars or wings with his feet. Many people believe that at least one of his airplanes would have flown if it had been equipped with an engine. Leonardo was a true pioneer of science, working wholly for the future. A hundred years before Bacon, he shower a firmer grasp of the principles of experimental science than did his successor. He had knowledge of many things which Newton, Gallileo, and Harvey would someday discover; but much of his knowledge was kept from mankind for years, since he wrote all his notes lefthanded, backhanded, and right to left across the page, which was hard to decipher.

On Easter Eve in 1519, Leonardo felt the end was near and made his will, then, on the day of his death, he renewed the Sacraments of the Church. He died on May 2, and was provisor of three different masses in three different churches in Ardroise. Sixty poor men were torch bearers in the funeral procession to St. Florentin, where he was buried.

teeth for a 1000 h.p. bite...

Undoubtedly you will recognize this application of a familiar technique for studying stresses. In this case, it was used to develop gears that are less than 5 inches in diameter yet easily transmit over 1000 horsepower.

Inherently, the design and development of aircraft engines offers unusual opportunities for applying basic engineering principles learned in school. In few other places can a technical graduate utilize his education and abilities more fully — gain recognition and advancement.

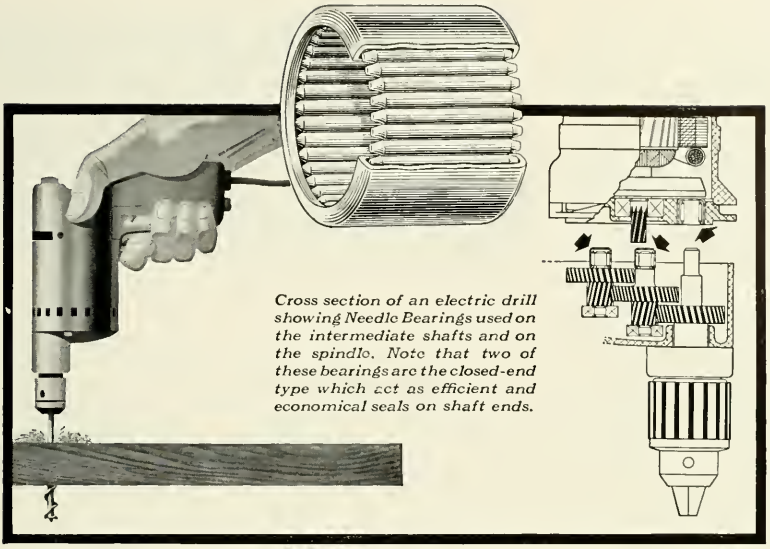
Many of our engineers who had important roles in developing the most powerful jet engine known to be in production — rated in the 10,000-pound thrust class — are still in their twenties.

To those young graduates who can see the career possibilities in the rapidly evolving field of aircraft propulsion, we can offer a real opportunity for growth and professional development.

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

East Hartford 8, Connecticut



Cross section of an electric drill showing Needle Bearings used on the intermediate shafts and on the spindle. Note that two of these bearings are the closed-end type which act as efficient and economical seals on shaft ends.

TORRINGTON NEEDLE BEARINGS

help make products more compact

These days, design engineers have to consider sales charts as well as blueprints and specifications.

Two portable electric drills, for example, may have the same capacity, the same speed, the same chucks and the same price, yet one may outsell the other. Factors like overall appearance, compactness, and light weight often contribute to product success.

Unique Design Promotes Compact Designs

The Torrington Needle Bearing has been used in many products because of the weight and space savings it affords. Its unique design—a thin hardened outer shell retaining a full complement of small diameter rollers—gives it maximum capacity in minimum space. In fact, for its size and weight, the Needle Bearing can carry higher radial loads than any other type of anti-friction bearing.

Permits Reduction in Size and Weight of Related Parts

In the electric drill shown here the small size of the Needle Bearing permits close shaft center distances to make for overall compactness. And, since Needle Bearings are press-mounted in plain round housing bores—without retaining rings or shoulders—housings can be made smaller and lighter. The fact that Needle Bearings require no inner race when running on hardened shafts results in further savings, without sacrificing capacity or durability.

Needle Bearings are in use on many other products where compactness and light weight are important design factors. Aircraft, small gasoline engines, hydraulic pumps and materials handling equipment are just a few of the products that utilize the Needle Bearing's high capacity and small size to good advantage.

THE TORRINGTON COMPANY

Torrington, Conn. • South Bend 21, Ind,

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON NEEDLE BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • BALL • NEEDLE ROLLERS

Make-Up of the Technograph

by Tom Brody, M.E. '56, and Don Kesler, E.E. '56

Of all the numerous operations that go into the preparation of the *Technograph* each and every month, the actual process of "make-up" is perhaps the least exciting, but certainly one of the most important. What constitutes "make-up?"

The "make-up" staff consists of Don Kesler, "make-up" editor and six assistants, Sandra Rains, Richard Gustafson, Craig Soule, Millard Darnall, Larry Geer, and John Erickson, all under the supervision of Tom Brody, assistant editor of the *Technograph*.

Make-up begins with the editorial department's monthly assignments, which must be given with consideration to the size of the magazine. As with all other magazines dependent on advertising as its mainstay, the *Technograph's* make-up must necessarily be arranged to best compliment our advertisers, all of whom are accustomed to national coverage in all the better professional and trade journals of engineering and related fields. With each ad insertion order comes a request for the position desired. Typical requests are "a right hand page in the rear or the front," "best possible," and "inside right front cover." Naturally an advertising company doesn't want its ad to appear facing the ad of a competitor, and it is not uncommon for several oil, steel, rubber, chemical, aircraft, and tool concerns to have competitive ads in one issue of the *Technograph*. In case of duplicate requests, preferance is given to the regular advertisers.

The advertising "dummy" is compiled with the assistance of Paul LaViolette, business manager for the *Technograph*. The "proofs" of the ads are pasted in before any of the "copy" or written material, called "galley" is inserted. The "galley," after being proofread by the editorial staff, is returned in the columnar form, of the same width as it will appear in the complete magazine. This pasting up of the master copy or dummy is the most time consuming single operation of the *Technograph's* monthly production cycle. Pictures or "cuts" are gathered and processed by Howie Hadler, associate editor, and must all be printed as proofs. The cuts are then trimmed to size and each complete article is measured for an estimate of length. As the number of pages for each issue must be a multiple of eight, it is of utmost importance to know the length of each article, as well as that of the advertising. The only means of extending or condensing the space alloted for each article is to vary the space fo rthe title or "head," and to fill in after an article with jokes, which are always on hand in the conventional galley form.

As the advertising dummy takes shape, the articles are clipped in their respective places in order to see that the available space is all filled and to gain an overall picture of the magazine as a unit. The real headaches start from this point, with the actual arranging of each page, complete with pictures and "head." The staff then cracks out the scissors, rubber cement, and blue pencils, and prepares for several long evenings.

A typical article may have a total of fifty galley inches, two two-column cuts three inches high, one single column cut two inches high, and a three column width graph two inches high, giving a total of seventy inches of material for the article. Each in the *Technograph* contains thirty column inches, and if three pages have been alloted for the article, twenty inches are left over for the head. The picture "cuts" all require sub-titles or "captions," as we call them, which, when combined for the four cuts mentioned above, will give approximately five inches when printed. This leaves fifteen inches for the head. For most articles this size head is too large; consequently, five inches of jokes added at the end would leave ten inches for the head. The head may be one, two, or three columns as the article deserves and or needs for a well balanced layout. The cuts must be arranged so as to produce a unit that is pleasing to the eye, and also in harmony with the advertising that may or may not be along side the article. Also, since April of 1953, the *Technograph* articles have been continuous—that is, they no longer are continued on page so and so as they were i nall previous issues of the *Technograph*. Articles follow page for page; so the reader should not see a new paragraph as he turns the page to finish the article he is reading. This detail often necessitates tearing out the entire article, and starting all over, as does a slight error in figuring the total number of inches for an article that is already too long for a first class layout.

Other tedious details arise with the placement of fractional page ads. Third page ads fit well, as they are half a page high and two columns wide; quarter page ads are horses of a different color. They must be run side by side, because of their one-and-one-half column size, but must not be run four to a page in compliance with the requests from the respective advertisers. If our advertising alottment for a certain month is three quarter page ads, the make-up staff must compose a fourth ad for the *Technograph* to use the remaining space. By this time, the old clock says one a. m., and we decide to give up for that evening. Several nites later, we find that we have all the articles pasted in, but all is not over. Each "cut" caption must be typed on sheets, corresponding to the number of column width of the caption. This procedure must be repeated for "by-lines," and "lead-ins," which give the author and introduce the article, respectively. The table of contents, containing an up-to-date staff tally, and the captions for the frontispiece and cover, referred to as a unit, as the masthead" must also be typed. Since the article's cut captions appear only on the separate typed sheets, the first few lines of each caption must be pasted below their respective "cuts" to aid the type setters after the captions have been cast on the linotype, according to their column width. The deadline is three a. m., and at this stage, we are ready for a quick trip to the Illini Publishing Company, where after half an hour of explanations and apologies to the type setters, we leave the *Technograph* for a few short weeks, that is until its time to start the cycle again.

"Mister, if you think you can kiss me like that again, I'll have something to say about it."

"Well, I'm going to, so start talking."

"The light switch is right next to the piano."

* * *

When you knock at the door and find hubby home, then, brother, sell something.

THE DU PONT DIGEST

Technical Sales

A major in glibness and a minor in solid information—those were the mythical requirements for a salesman in the old days. But they really never sufficed for a man selling the products of chemical technology.

Today, the diverse applications of Du Pont's 1200 products and product lines create a need for trained sales personnel representing many different technical backgrounds. These men must deal intelligently with problems in chemistry and engineering applied to such fields as plastics, ceramics, textiles, and many others.

Du Pont technical men are assigned to various types of technical sales activity. In some spots they are equipped to handle all phases of selling. In others they deal mainly with customer problems. Also, certain departments maintain sales development sections, where technical problems connected with the introduction of a new product, or a new application for an established product, are worked out.

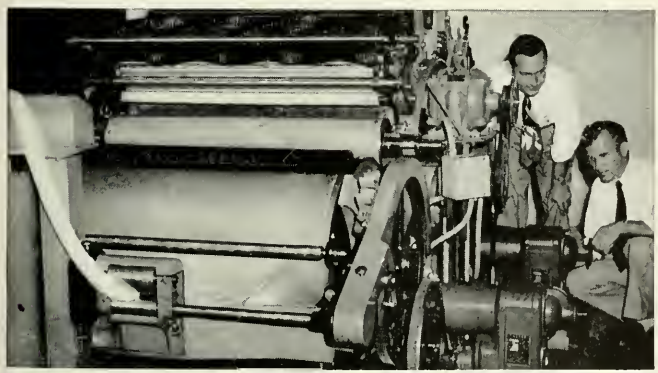
For example, a technical man in one of Du Pont's sales groups was recently called upon to help a customer make a better and less expensive hose for car radiators. Involved were problems in compounding, such as choice and amount of neoprene, inert fillers, softeners, accelerators, and antioxidants. Correct processing methods also had to be worked out, including optimum time and temperature of milling and extruding. The successful completion of this project naturally gave a good deal of satisfaction to the customer as well as Du Pont.

In another case a customer wanted to reduce carbon contamination of arc welding rod stock. A Du Pont technical service man suggested changes in cleaning procedures that lowered contamination by 90 per cent. The new process also reduced metal loss during heat treatment—a benefit that more than offset the cost of the additional cleaning operations.

Technical men interested in sales work usually start in a laboratory or manufacturing plant where they can acquire needed background. Depending on their interest and abilities, they may then move into technical sales service, sales development, or direct sales.

In any of these fields, the man with the right combination of sales aptitude and technical knowledge will find interesting work, and exceptional opportunities for growth in the Du Pont Company.

W. A. Hawkins (*left*), B.S.M.E., Carnegie Tech., demonstrates extrusion of "Teflon" tetrafluoroethylene resin for a customer.



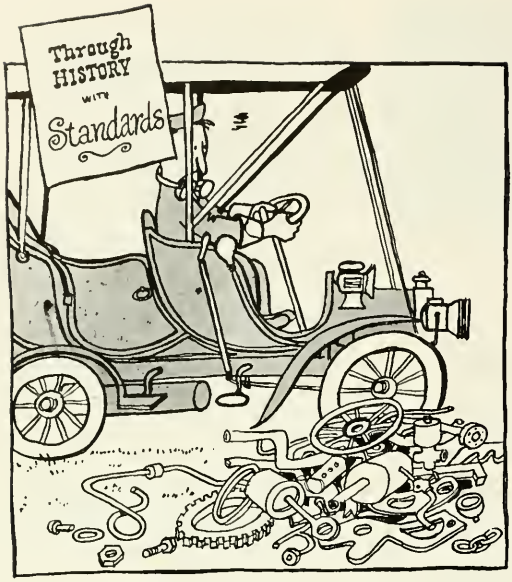
James A. Newman, B.S. in Ch.E., North Carolina State (*left*), discusses study of optimum settings and conditions for carding nylon staple with Prof. J. F. Bogdan of North Carolina State's Research Division.

ASK FOR "Chemical Engineers at DuPont." This new illustrated booklet describes initial assignments, training, and paths of promotion. Just send a post card to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware. Also available: "Du Pont Company and the College Graduate" and "Mechanical Engineers at Du Pont."

DU PONT

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Watch "Cavalcade of America" on Television



All are but parts of one stupendous whole.

How A Young Industry Proved Its Parts Were Interchangeable

A dramatic and convincing demonstration was given in London in 1908 of the rapid progress toward standardization that the United States had even then achieved in the manufacture of its automobiles.

In February and March of that year, Henry M. Leland chose three one-cylinder Cadillac cars at random from the warehouse of the agency in London. The cars were taken to the Brooklands Race Track and there were completely dismantled. A control commission of the Royal Automobile Club of England scrambled the parts into three piles of 724 each and then replaced 89 of the parts with new parts from stock.

Three new cars were reassembled from the piles of standardized parts without hand fitting. The only tools allowed were wrenches and screwdrives; files and emery cloth were forbidden. The cars were driven 500 miles over the Brooklands Track with only one minor adjustment.

How to lick dust, moisture and acid fog

prevalent in the atmosphere surrounding the Rumford, Me., mill of the Oxford Paper Company posed a problem in power circuit maintenance. The combination of these elements caused wooden structures and even over-voltage insulators to become conducting, resulting in phase-to-phase flashovers and burndowns when ordinary overhead wires were used.

The solution of this serious problem was found by substituting Okolite-Okoprene Self-Supporting Aerial Cable for the open wires. According to company officials, the combination of Okolite high voltage moisture and heat resisting insulation, protected by non-conducting weather and chemical resistant Okoprene sheathing, has eliminated this trouble.

● ● ● ●

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE insulated wires and cables

8786

FRICK Evaporative Condensers Save Water and Power!

Whether you operate an air conditioning system, a processing plant, or a hotel . . . if you use refrigeration, you can save 95% of the cooling water . . . and lots of money . . . with these efficient condensers. They combine a condenser and a cooling tower . . . evaporate 5% of the water instead of throwing all of it away. Built in 12 sizes, for use with either ammonia or Freon.

300-ton condenser being assembled.

For a position with a future inquire about the Frick Graduate Training Course in Refrigeration and Air Conditioning. Operated over 30 years, it offers a career in a growing industry.

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.

put yourself in his place . . .

A year ago he was knee-deep in textbooks, plugging for his B.S. Tonight he's on his way to Vancouver, or Miami, or Portland, Maine. Tomorrow he'll help an Alcoa customer make a faster ship, a stronger shovel, a lighter highway trailer.

In Alcoa laboratories, plants and sales offices from coast-to-coast, ambitious young Sales Development Engineers are helping to make aluminum more useful, in more ways, to more people. We need more men just like them to help us meet ever-growing demands for Alcoa Aluminum . . . Alcoa "know-how".

Maybe you are already thinking about trading your textbooks for a position in production supervision, industrial research or sales engineering. Tell us about it, give us an idea of your background in Chemical, Electrical, Mechanical, Metallurgical or Industrial Engineering.

Good men go places fast with Alcoa, in their daily associations with leaders in the aluminum industry. Right now it may be quicker than you think from a seat in the classroom to your career with Alcoa. Why not find out?

Your Placement Director will be glad to make an appointment for you with our Personnel Representative. Or just send us an application, yourself.

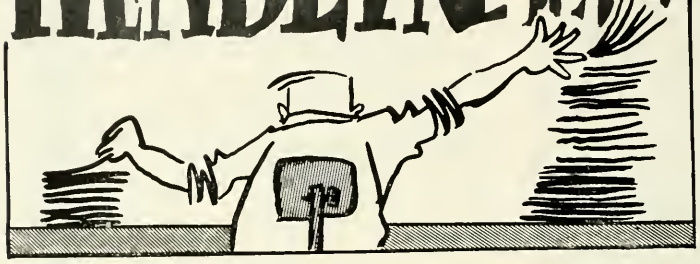
Aluminum Company of America, 1825 Alcoa Building, Pittsburgh 19, Penna.

ALCOA **ALUMINUM**

ALUMINUM COMPANY OF AMERICA

ALCOA ON TV brings the world to your armchair with "SEE IT NOW" featuring Edward R. Murrow. Tuesday evenings on most CBS-TV stations.

SKIMMING INDUSTRIAL HEADLINES



by Larry Kiefling, M.E. '56

World's Largest Electrical Equipment

The largest single piece of electrical equipment—in physical size—ever built, was placed in operation for the Corps of Engineers, U. S. Army, by the General Electric Company. Officials of G. E.'s large motor and generator department revealed that the first hydraulic turbine-driven generator at McNary Dam on the Columbia River started operating for tests recently.

The giant 1,500-ton unit is the first of twelve similar generators for the project. Each is rated at 73,684 kva.

The units are so large that the larger components of each are shipped in sections. Between 35 and 40 railroad cars are needed to transport all the components required for a completed unit to the powerhouse.

The first two of the McNary generators will be turning out electricity for the Northwestern United States by the end of the year. A third is nearly ready for shipment.

G-E engineers supervise assembly and testing of the generators before the units are turned over to the Corps of Engineers for regular service.

The last of the twelve generators scheduled for McNary Dam will be shipped in 1955.

New Tools for the Materials Engineer

Materials engineers at Westinghouse Electric Corporation are employing new tools to speed measurements in laboratory testing.

One is the fluorescent x-ray spectograph which is used to determine within close limits the constituents of a given alloy. While standard chemical methods are slow, the new method allows a test to be made in about 30 minutes. A beam of x-rays is shot obliquely at a small wafer of the alloy. This produces secondary rays, each combination of wavelengths being characteristic of a particular element. Thus the secondary-ray output is first separated by a grating crystal and then scanned through an 180-degree arc with a Geiger counter. The angle of the secondary ray identifies the element; the intensity—its amount. The method is accurate to about 0.3 percent for components existing in quantities of more than five percent in an alloy. A test is made in about 30 minutes. This method of analysis supplements the emission spectograph, which is suitable for identification of small or trace amounts of alloy elements.

Another device has been developed to measure the permeability of new magnetic materials over a spectrum of frequencies. With it the initial permeability of any magnetic material can be measured over the frequency range of 400 to 10,000 kilocycles.

Measurement of hysteresis loops at high frequencies has been another extremely difficult task. A laboratory device now displays these loops on an oscilloscope where they can be photographed or measured. It is good for frequencies up to one megacycle.

Temperature of Flame

Two General Electric Research Laboratory scientists have called upon a discovery nearly a century old to improve performance of space ships of tomorrow.

Dr. Herbert M. Strong and Dr. Francis P. Bundy needed an improved method for measuring temperatures over the entire cross-section of a rocket motor flame to determine the motor's efficiency.

They knew that almost any thermometer introduced into the flame would quickly disintegrate. Thermometers relying on probes placed in the flame were not sufficiently accurate.

So the pair harked back to methods based on the 1859 discovery of G. R. Kirchoff, a German physicist. Kirchoff found that a flame containing sodium vapor gives off the same amount of sodium radiation it absorbs from a tungsten lamp when both are at the same temperature.

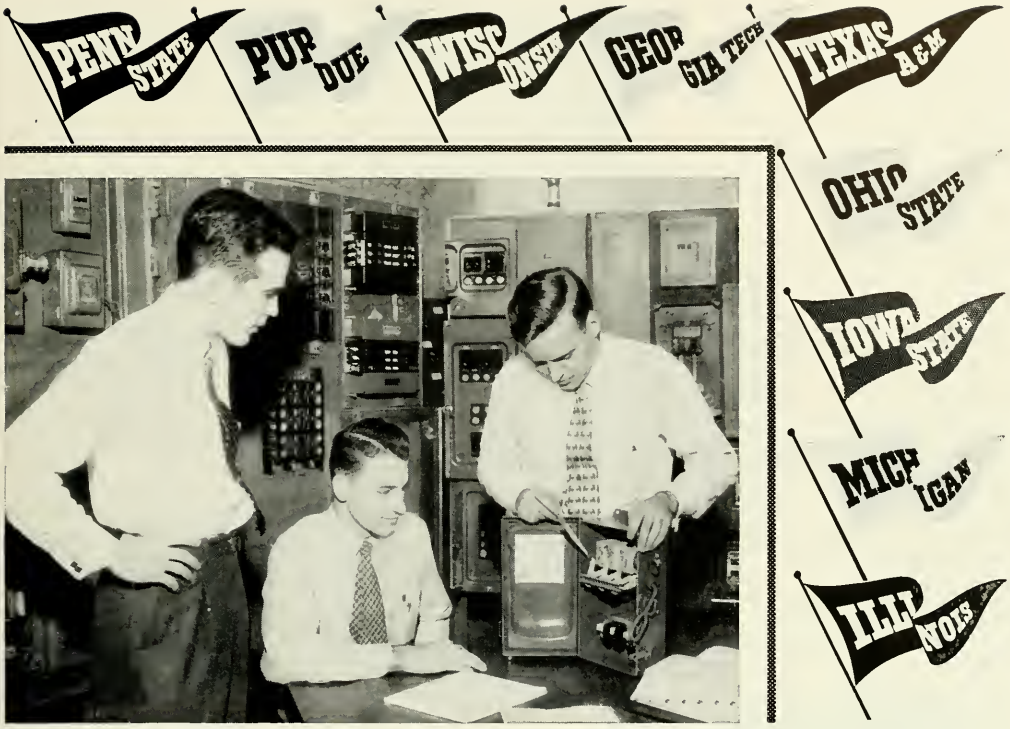
The established method of measurement, based on Kirchoff's law, is to pass a light beam from a calibrated comparison lamp through the flame to which sodium vapor has been added, then into a spectroscope. There the sodium radiation can be seen against the background radiation of the comparison lamp.

If the lamp is hotter than the flame, the sodium radiation appears dark against the background of the spectrum. If the flame is hotter, the sodium radiation is bright against the background.

When the two have the same temperature, the sodium radiation merges with the background. This point of merging determines the flame temperature. But in flames that have varying temperatures throughout, the method does not give the correct reading for a broad cross section.

With this method in mind, the two G-E scientists worked out extensive improvements that have enabled them to accurately gauge complicated temperature structures in a single flame.

They made use of a sodium-vapor light with a known temperature as a means of measuring heat in the flame structures. To magnify the flame spectrum they substituted a Fabry-Perot in



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terferometer for the conventional simple prism spectroscope.

The method used by Strong and Bundy is similar to the established one. But the scientists found that by using a sodium vapor lamp as a means of comparison and the interferometer to magnify the spectrum of the sodium radiation, they could find more detailed information than by the older method.

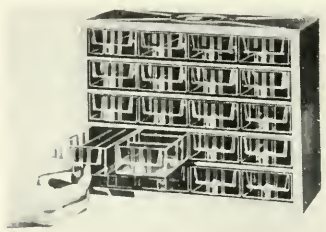
"In effect," Dr. Strong said, "the method enables us to peer through various zones of a flame into more distant ones and determine their temperatures accurately."

In addition, he said, it "enables one to survey the temperature structure in a large section of the flame in one observation. By older methods a flame could be examined only one point at a time."

The gauge, recently patented, has helped rocket and jet technicians to determine accurately how efficient are various flames. Indirectly, the device also shows how much energy is converted into thrust for rockets, jets, ram jets and similar propulsion mechanisms.

Transparent Cabinets

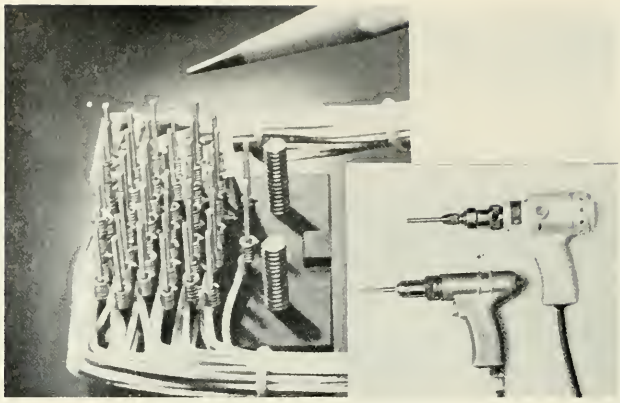
A new idea in plastics are these clear plastic cabinets. Cabinets in this new line, have been developed to solve the



small parts filing and storage problems of factories, banks, offices, schools, and garages, as well as those of hobbyists and persons with home workshops. Called "See-Thru" cabinets, they are made by General Industrial Co., of Chicago, Ill. The cabinets are available in numerous combinations of large and small drawers and steel and plastic drawer combinations, in units that range in capacity from eight drawers to one hundred and twenty-eight drawers, to serve every need. Adjustable drawer cabinets and identification labels are included with every cabinet.

Solderless Connections

Recently announced is a method for making electrically efficient, mechanically sound connections without solder. The key to this new method is a pistol-grip hand tool, two examples of which are pictured. Developed jointly by Western and Bell Laboratories, the solderless method is currently being used in manufacturing locations to wire switching components. The tool has a rotating spindle which wraps wires tightly around terminals. As shown in the photograph of an experimental terminal block, as many as 44 connections can be made in a space of less than 1 square inch. The new method is faster, safer, and is said to give better connections than conventional methods using solder.



New solderless method permits making very closely spaced connections. The inset shows the electrically powered tool for making the wrapped solderless connections.

Pulse Counter

A tube that counts at rates up to 2,000 pulses per second and that can remember the number of pulses has been developed by Bell Laboratories and is currently in production. Pulses fed into the tube, which is designated as the 6167 stepping tube, progress from one to another of the tube's multiple cathodes. Each cathode glows as it receives a pulse; last cathode to receive a pulse continues to glow when the pulses stop. At the resumption of the pulse series, the tube begins stepping from the last pulse registered. The tube's counting can be registered on electrical recording devices.

New Aircraft Flowmeter

Jet pilots soon will have a means for keeping a continuous, more precise check on how much fuel their aircraft consumes in flight as a result of a new device developed here by engineers of the General Electric Company.

The equipment, called a mass flowmeter, measures the actual fuel being gulped down by thirsty jet engines in terms of pounds per hour and indicates it on the aircraft's instrument panel.

According to G-E engineers, the flowmeter will aid pilots or flight engineers by making it simpler for them to compute remaining flying time. It also will give them a quick method of evaluating engine operating efficiency through comparison with data gathered from past experience.

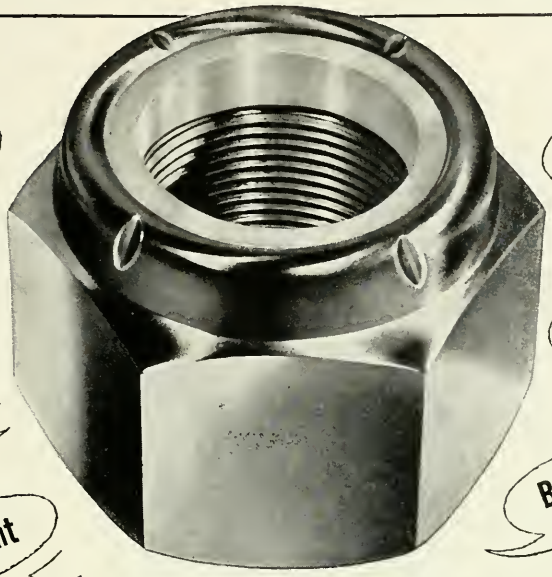
The heat content of jet fuel depends on its weight rather than its volume. This means, the engineers point out, that the specific gravity of the fuel (its weight compared with the weight of water) becomes a prime factor in the amount of power it will give to the engine. Since specific gravity varies with the type of fuel and its temperature, measurement of the mass of the fuel at the time of its use is essential in determining the efficiency of fuel consumption.

Silicone Rubber Insulation

A putty-like silicone rubber coating compound promises marked improvements in electrical insulation and may eliminate many expensive metal cans now protecting coils and other small electrical components. Possessing a unique combination of physical toughness and electrical strength undiminished over a wide temperature range, the versatile new material also is useful for such non-electrical products as heat resistant engine gaskets and flexible heater ducts.

SE-100 silicone rubber has a higher dielectric strength than any other known silicone rubber coating material, according to Dr. Charles E. Reed, general manager of the General Electric Company's Silicone Products Department, who predicts it will find wide application for Class H insulation in electrical equipment used under hot or moist conditions.

Whenever fastening problems arise...



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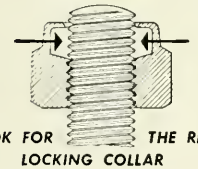

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NUCLEAR REACTOR IS SAFE DEVICE

A nuclear reactor, the "furnace of an atomic power plant, is fundamentally a safe device, if proper precautions are taken in its design, housing, and location," a scientist explained recently.

Speaking before the 1953 Conference on Nuclear Engineering at the University of California, Dr. Henry Hurwitz, said that the nuclear reactor is normally a placid and sluggish machine.

Dr. Hurwitz, a member of the staff of the Knolls Atomic Power Laboratory, which the General Electric Company operates for the Atomic Energy Commission, pointed out that the violent action of an atomic bomb is not the normal characteristic of a nuclear chain reaction in which atomic energy is released.

"In fact," he added, "it is only attained with great ingenuity and effort."

"Some early discussions of atomic energy emphasized the difficulties of controlling a reactor, but this emphasis was quite misplaced because, in actuality, a nuclear reactor is very easy to control," he said.

"If a nuclear reactor does get out of control, the nuclear explosion is comparatively minor. A serious nuclear reactor accident should be thought of, not in terms of an atomic bomb explosion, but rather in terms of the explosion of, let us say, the gasoline tank of an automobile."

The chief hazard associated with operation of a power reactor is in the radioactive products released as the atoms of uranium and other atomic fuels undergo splitting, or "fission" in the atomic energy-releasing process, he said.

A serious accident to a nuclear reactor, which would only occur in the remote event that all of a number of safety devices happened to fail at the same time, might release some of these "fission products" in the vicinity.

The inherent safety and reliability of the plant, location of the site, and the design of the reactor building are the three major factors in determining the safety of an atomic power plant, according to Dr. Hurwitz.

However "the energy yield which would be likely in nuclear accidents is small enough to make it feasible to contain the fission products escaping from a reactor in a gas-tight building," Dr. Hurwitz said.

A "very substantial amount of engineering development" will be required before a commercially successful atomic power plant is built, or even before "a reasonably accurate cost estimate of such a plant can be made," George S. Mikhalapov, G-E manager of engineering development in the Knolls Atomic Power Laboratory, told the conference. He presented a paper prepared in collaboration with his associates Kenneth A. Kesselring and Thomas Trocki.

Many nuclear reactors have been built and are now in operation, harnessing nuclear fission for various applications. Their construction costs are known, but these are of little help in determining the imminence of commercial atomic power, he pointed out.

"In the first place," he said, "none of these reactors constitutes anything like a prototype of a commercial power plant. In the second place, the cost figures are usually construction costs that omit the cost of years of research and development which made construction of these reactors possible, and which are still ahead of us in the case of atomic central stations."

This does not mean, he added, that commercial atomic power plants are either impractable or improbable, "but rather that their advent will have to be preceded by a very considerable amount of engineering analysis, engineering development, and particularly development of special materials required by the unique features of such plants."

One of the almost unique engineering problems confronting the designer of an atomic power plant has to do with the core where nuclear energy is released. After the splitting or fission of a fuel atom occurs, the fragments fly away from the site with a speed of some 5,500 miles a second, he explained. Heat is generated by friction as they are quickly brought to a stop after travelling about three ten-thousandths of an inch.

"This means that heat is liberated locally, and any material in the reactor core, including unfissioned fuel, is subjected to very rugged physical bombardment," he said. "A reactor as a heat source is thus somewhat difficult to compare directly with a conventional combustible or chemical fuels furnace," he added.

Mr. Mikhalapov said that additional engineering problems result from the fact that operating a reactor makes its parts inaccessible. Bombardment by the nuclear particles called neutrons, which keep the process going, alters the physical properties of materials, and also makes them radioactive.

As an example, he cited the cobalt in standard stainless steel which, after a short run at full power, "would become 100 times more radioactive than an equivalent weight of radium and would remain radioactive for more than 25 years. Any hope of waiting for a cooling-off period here does not exist."

Although many ingenious devices have been constructed to permit radioactive materials to be handled by remote control, they do not give the answer, he said. The radioactive levels they work with are low compared to those in parts removed from a power reactor that has just been shut down. "Special provisions requiring long time delays must be made to permit radioactivity in such parts to decay to controllable levels," he stated.

"Faced with such facts," he continued, "the designer must strive for such simplicity that failure or malfunction is almost impossible—or design so that remote replacement or repair is possible and accept the great increase in complexity and decrease in reliability. There is undoubtedly a compromise, which after experience has been attained will enable the clearer resolution of the design worries and the ghosts.

"Until such experience is available, the reactor designer finds himself squeezed between (a) the realization that a serious nuclear incident or reactor failure may set back the development of nuclear power for years, and (b) the much more certain knowledge that to design with the intent to protect against all eventualities results in high costs, long delays, and, paradoxically, a less reliable unit."

Then there was the overworked EE who told the story about the politically minded ion who heard that there was going to be an electron so he went to the poles and volted.

* * *

She: "You remind me of the ocean."
He: "Wild, romantic, and restless?"
She: "No, you make me sick."

* * *

In a certain town, a beautiful chorus girl sued a rich banker for breach of promise and was awarded $10,000. Shortly after leaving the court she was struck by an automobile and had eight ribs broken. The same judge awarded her eight dollars.

Moral: Never play with a woman's heart—kick her in the ribs.

* * *

The height of bad luck—seasickness and lockjaw.

PIPES OF CLAY

by David Skylar

EDITOR'S NOTE: It has been the policy of the editors of this magazine to bring to its readers articles written by people in industry which they believe would be of interest. "Pipes of Clay" by David Skylar has been sent to us by the Sanitary Engineering Committee of the National Clay Pipe Association. We feel that this article will be of particular interest to Ceramic and Sanitary Engineers.

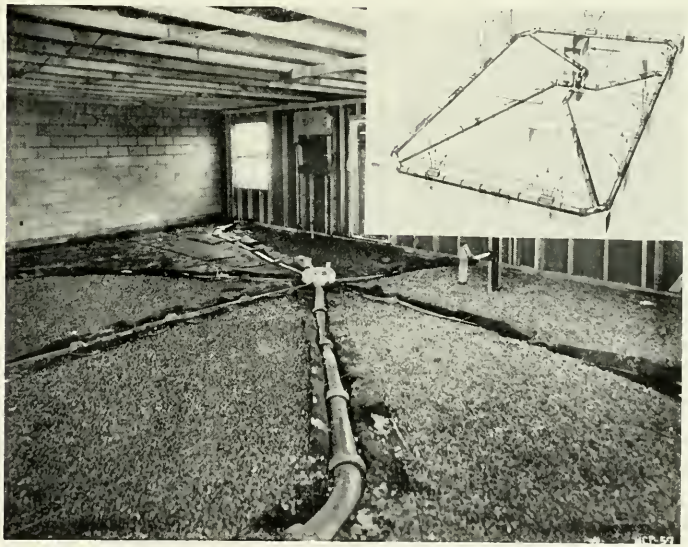
Clay is a stiff, plastic earth, composed mainly of aluminous silicate, formed through the ages by erosion and decomposition of rocks. It is found, in some form or other, practically everywhere. And it is as indispensable to modern living today as it was to the ancient Greeks many centuries ago. In one industry it has been used for the past five thousand years—the vitrified clay pipe industry.

No one knows exactly when sewer pipe made from clay was first manufactured and used. Recently, Homer Thompson, Professor of Archaeology of the American School of Classical Studies at Athens, Greece, uncovered a clay pipe line which was installed in the early Fifth Century, B. C., in ancient Athens. The clay pipe line was discovered during excavations of the ruins of Agora, a public square about 25 acres in size, just below the famous Acropolis. This may have been the world's first shopping center.

Greek plumbers 2,500 years ago did an excellent job of designing the pipe. A modified bell and spigot was used, which is similar to the house connection pipe used today. Engineers, who examined the pipe after it was excavated, said it was in good enough shape to be put back into use.

Clay pipe manufacturers proudly boast of the antiquity of their product, but at the same time they are proud of their rightful place in the parade of modern production techniques and developments. They point to such innovations as continuous tunnel kilns, electrically controlled grinding and mixing machines, automatic forming and trimming, palletizing and fork-truck handling. With a raw material older than civilization itself, the clay pipe industry is progressive indeed. Today, the annual volume output of the industry is approximately 2,000,000 tons. In the past five years the industry's capacity has expanded by more than 50 per cent to meet demand from municipalities, industries and other users of clay pipe.

Vitrified clay pipe was first made by machine in this country in 1854. No one knows how much has since been made and used. It is estimated that in the last four decades over 1,000,000,000 feet of clay pipe have been used in this country alone.



Many home builders are now using this new and revolutionary system of duct heating for basementless homes. Vitrified clay pipe is used as ducts to distribute warm air.

Raw clay must have certain qualities to be ideal for pipe making. It should be coarse-grained and uniform, and free from an excess of organic material and free metals. It should have a long firing range, meaning that heat can be applied to the pipe for a long time period to soften the clay grains to a fusing point, without actually melting the grains.

At a typical clay pipe plant the clay is pulverized and mixed with water to form a uniform doughy mass. This is pressed through a die and shaped into pipe under tremendous pressures. Both steam and hydraulic pressures are used. The pipe is formed under a vacuum which draws all air from the clay as the pressure is applied. Elimination of air bubbles results in greater strength, truer dimensions, decreased absorption, and elimination of flaking.

The "green" or unburned pipe is dried in temperature-controlled rooms through which hot air is blown for four to seven days. This must be done to "set" the pipe before it can be "burned" and vitrified at high temperatures.

From the drying rooms, the pipe goes to big oven-like kilns, where it is "burned" to a temperature higher than the melting point of iron, 2,000 F. This burning is known as vitrification, and fuses the clay grains into a hard, impervious pipe which resists the penetration of any foreign substances.

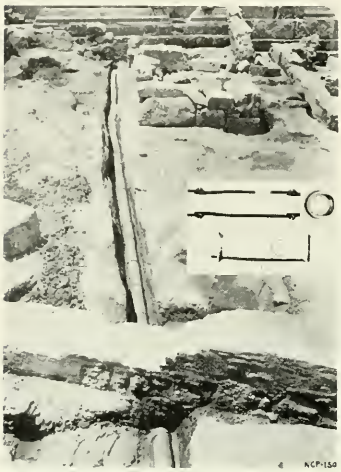
Two main types of kilns are used by clay pipe producers—the "beehive" kiln and the "tunnel" kiln.

The beehive kiln is so called because of its remarkable resemblance to a bee-

hive. It is a round-roofed structure 30 to 40 ft. in diameter, and 16 ft. from floor level to the roof peak.

Tunnel kilns look just like the name implies. The pipe, after it comes from the drying room, is piled on cars about 12 ft. long. These cars move through the kiln on tracks.

Heat in tunnel kilns is maintained at a constant temperature and may be supplied by oil, gas, or coal. Heat is applied direct with flame from the burners playing on the pipe itself. Slow heating and cooling of the pipe is accomplished by moving the pipe load from the tunnel entrance, through a central fire zone, and on out to the tunnel exit.



Greek plumbers 2500 years ago really knew their business. This clay pipe line was recently uncovered during excavations of the City of Agora, near the famous Acropolis in Greece.

The huge excavation required for this sewer in Monsanto, Ill., is clearly shown from this view from the top of the cut. The form work for the concrete is still in place. In front of this is exposed pipe with reinforcing in place ready for forms and concrete.

Research activities for the clay pipe industry are conducted in their own laboratory in Los Angeles under the direction of Dr. Harvey House, nationally famous research chemist. In the years that Dr. House has been supervising this industry's research, he has assembled facilities and equipment without duplicates anywhere, and all specificially designed to study vitrified clay pipe and kindred products. Much of this equipment, Dr. House designed himself to meet testing requirements.

For sewage and drainage work, certain piping has inherent advantageous characteristics. Research determines what these are. For example, in non-pressure installations such as building sewers, vitrified clay pipe is permanent, it is resistant to chemical action of all products of sewage decomposition. It is also resistant to alkaline or acid ground water and to disintegration by chemicals and spent waste.

To substantiate findings of the Los Angeles research laboratory, tests were made at various universities on sections of vitrified clay pipe immersed in sulfuric acid. In Chicago, where additional testing was forwarded, acetic, hydrochloric and nitric acids were used and in none of these tests was the vitrified clay pipe affected.

Because of these outstanding characteristics, engineers are teaching an old product new tricks. For example, the new Health Sciences Building at the University of Washington, contains a unique system of vitrified clay pipe for venting chemical fumes from the medical and dental laboratories. In various phases of their study and research, students and researchers find it necessary to cook hydrochloric and nitric acids and other substances which emit powerful fumes. This is especially true of their work with radioactive isotopes. Hoods catch the fumes in the laboratories and direct them into clay pipe ducts. Acid proof fans pull fumes up to the roof and disperse them harmlessly into the upper air. Vitrified clay pipe was chosen for the ducts because it is completely immune to the disintegrating action of acids and other chemicals.

Many home builders are now using this new and revolutionary system of duct heating for basementless homes. Vitrified clay pipe is used as ducts to distribute warm air.

This heating method economically combines the favorable factors of radiant heat with forced warm air perimeter heating. Clay pipe is the ideal duct material. It is inexpensive and easy to install and never wears out.

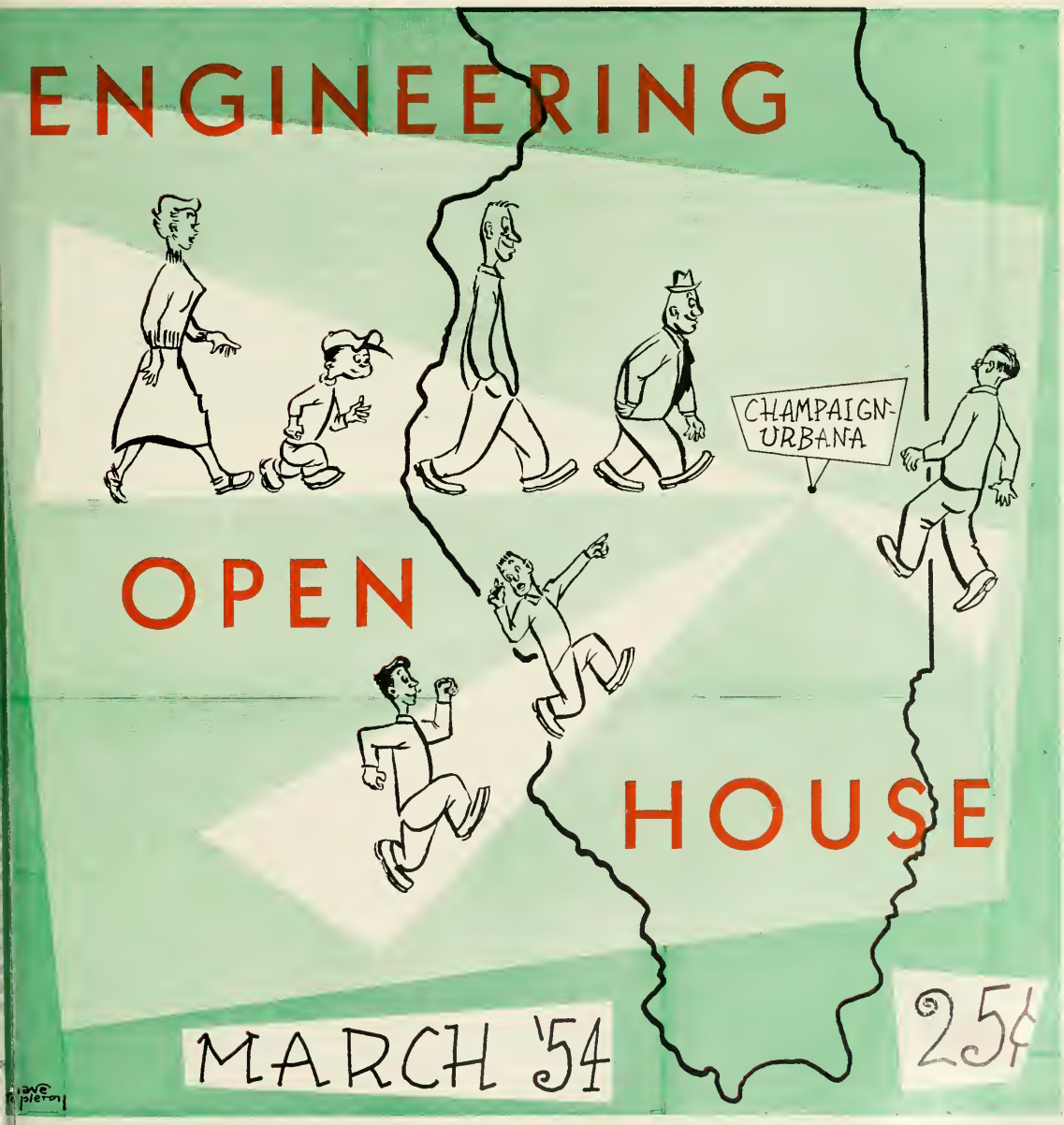
Another outstanding clay pipe installation has been made in nearby Monsanto, Illinois. Though a village, Monsanto is no sleepy country settlement. It contains some of America's heaviest industries—and hence it puts unusual demands on its sewers. Most recent project at Monsanto is a twin industrial sewer which will serve the following companies: American Zinc, Darling Fertilizer, Lewin-Mathes, Monsanto Chemical, Midwest Rubber Reclaiming, and Socony-Vacuum.

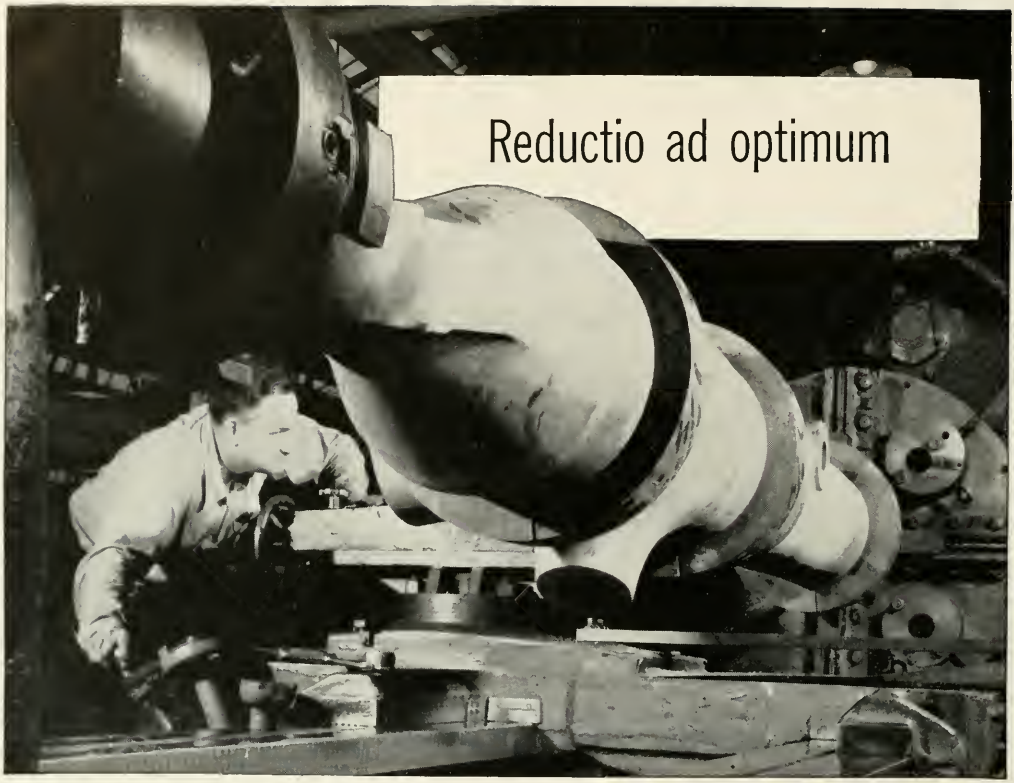
In specifying pipe, the engineers realized that the line would be carrying weak acids and other chemical wastes. Hence, they chose vitrified clay pipe, which is proof against chemical attack.

There was a complicating factor, however. Clay pipe is made no larger than 36 inches in diameter, and the volume of wastes to be carried here required more capacity than this. Yet rather than consider other pipe materials which are available in larger sizes, the engineers preferred to use multiple clay pipe lines.

Engineers designing today's modern sanitary systems have come to agree with the ancient Greeks that one of the most inexpensive and safest means of guarding the health of the people is with the use of clay pipes.

ILLINOIS TECHNOGRAPH





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Published eight times during the year (October, November, December, January, February, March, April and May) by the Illini Publishing Company. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois, under the Act of March 3, 1879. Office 213 Engineering Hall, Urbana, Illinois. Subscriptions $1.50 per year. Single copy 25 cents. Reprint rights reserved by *The Illinois Technograph.* Publisher's Representative—Littell Murray-Barnhill, 605 North Michigan Avenue, Chicago 11, Ill, 101 Park Avenue, New York 17, New York.

THE ILLINOIS TECHNOGRAPH

volume 69 number 6

contents:

the world as his workshop ---- 7
xv-1 ---- 9
thru chemistry ---- 12
business and educatian ---- 19
civil engineer ---- 20
tickle your curiosity ---- 24
haw to attract and hold engineering talent ---- 29
my boss ---- 30
combes' cagers ---- 32
there's more to it thon pots ---- 36
i'm chief tech-i-engi-graph ---- 41
aviation noise ---- 42
the rocketeering illini ---- 45
now hear this ---- 48
engineers ---- 50
feature editor ---- 54
skimming industrial headlines ---- 58

our cover

March 26 and 27 is the date of the 1954 Engineering Open House. At that time high school students and other interested persons will came to the U. af I. engineering campus from all parts of the state. The cover depicts the rush of high school students to the Open House.

our frontispiece

One of three pole units of o General Electric circuit breaker for the nation's first 330-kv power transmission network is shown being unloaded at the Muskingum River Plant of the Ohio Power Company. The 80-ton breaker is more than 11 feet in diameter and has a 3550-gallon capocity. (Cut courtesy General Electric)

The World as His Workshop

. . . A Look at Mechanical Engineering

by Frank W. Ridgway, M.E. '54

Engineering training prepares students for professional work in engineering and for technical and semi-technical positions in industry, commerce, and government. Very often, the scope of the engineering field is not realized by the layman. To acquaint more people with the profession of engineering, not only those having a natural curiosity of engineering problems, not only those considering engineering as a career, the College of Engineering will be presenting its annual open house on March 26th and 27th. Both engineering teaching methods and the products of applied engineering practice will be displayed.

One of the largest branches of engineering in general is mechanical engineering. Differentiating from electrical, ceramic, chemical, or civil engineering, mechanical engineering covers the theory and practice of the generation, transmission, and utilization of power. This involves the operation, design, testing, and construction of machines of all kinds. In practice, emphasis is given to the engineering and economic principles of machine operation, performance, production, and problems of production management.

A graduate mechanical engineer has the world as his workshop. Realization of a problem, analytic thinking, and decisive action are taught to the mechanical engineer above all else, and these are the requisites for success in any field. In his own field a mechanical engineer has several alternatives—aeronautics, air conditioning and refrigeration, machine design, petroleum production, power, production control, and research. Basically, these fields are closely related, and a graduate may pursue his greatest interests.

All phases of mechanical engineering will be demonstrated during the open house this year. Rather than producing a show composed of the mysteries of mechanical phenomena, it is desired to reveal just how a mechanical engineer learns and what he does.

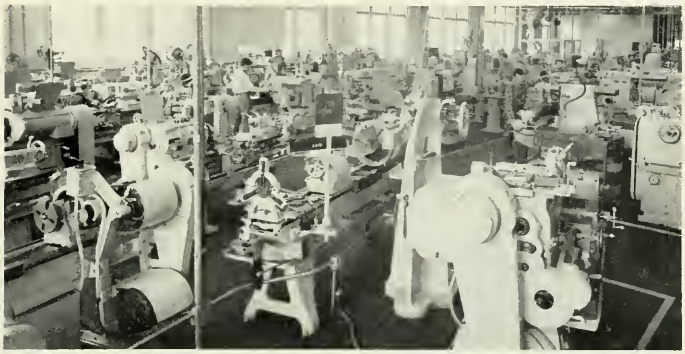

Fig. 1—Machine Tool Labaratary

Models and actual equipment used by the machine and tool designers will be shown and explained by the best undergraduates in this field. Another one of the more theoretical phases of mechanical engineering is that of automatic control and actuating mechanisms. A vivid demonstration of several commonly used and basic devices will be in operation.

Shown in figure 2 is the power laboratory where theories and mathematical predictions are tried in practical applications. In this laboratory are engines, turbines, pumps, air conditioning and refrigeration apparatus, research projects, and power generation equipment—including a complete, miniature power plant capable of supplying electricity to a medium-sized family home. During the open house every piece of equipment will be running or will be run at the request of interested observers.

A section of the internal combustion

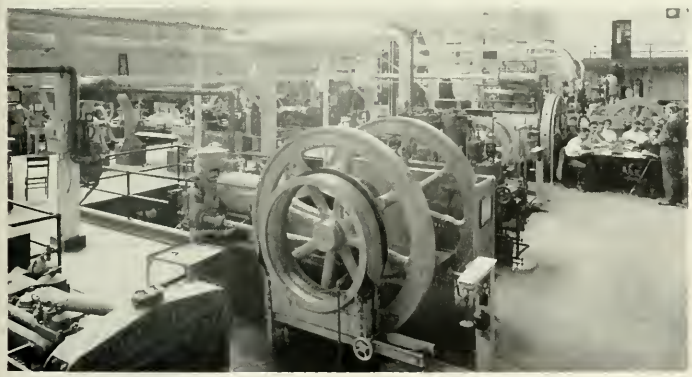

Fig. 2—Mechanical Engineering Power Laboratory

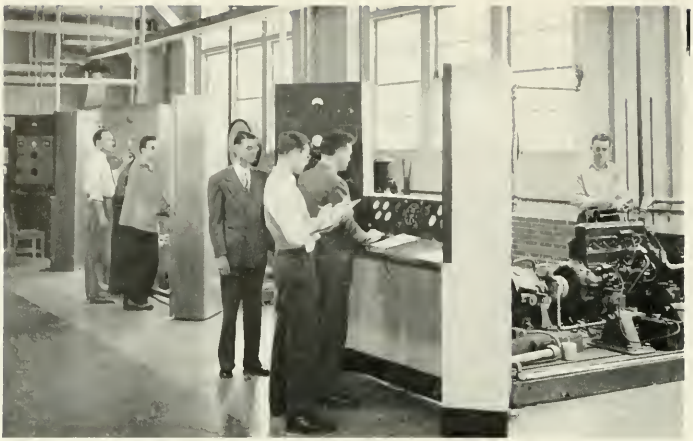

Fig. 3—Performance testing Chevrolet engine in the Internol Combustion Engine Laboratory.

engine laboratory is shown in figure 3. In this laboratory tests are performed on standard automobile, truck, tractor, marine, and stationary engines to determine fuel economy, power output, lubrication problems, and general design problems. These engines and their instrumentation will be in operation during the open house along with three special engines used in high altitude, fuel, and design research. A full-size, cut-away, prewar automobile chassis will be functioning showing all of its moving parts.

In the manufacture of any product, the first step is to obtain raw material in a workable form. From the foundry odd shapes and large units are obtained as castings. Through the engineering week end the entire foundry will be in operation casting iron, aluminum, and bronze, making molds, and cleaning finished castings.

Machines and consumer products are also fabricated from basic structural shapes by welding. This method is becoming progressively more important because of new materials and techniques being developed. In the welding laboratory in the mechanical engineering building, will be demonstrations of arc, oxy-acetylene, and spot welding, torch cutting of steel, metal spraying devices, and weld testing.

After rough shapes are fabricated, machining operations follow. In the neat, clean shop shown in figure 1, there is at least one of almost every type of machine tool used by industry, including automatic machines which will produce finished gears and screws as long as raw stock is available, and precision machines capable of maintaining an accuracy of 1 10 the thickness of a human hair. Because of the ever-changing nature of machining processes, the mechanical engineering department maintains a machine tool research laboratory where machining stresses, finishes, cutting fluids, new processes, and tools are studied. All these will be in operation during the 1954 open house.

To provide desired physical properties of wear, hardness, or machinability, metals are subjected to many different heat treatments. This technique is a science in itself. In the laboratory standard heat treatments will be performed. The observer will see what occurs within the metal structure and the effects of these changes. He will also see how metals can be heated to redness almost instantaneously in an induction heater and how temperatures are taken inside of a white hot furnace.

It is a basic premise of industry that the system which produces the greatest return, especially financially, is the one which will be used. The job of an industrial engineer is to determine through past experience, analysis, and predictions the best way to get a job done. At the open house, leading undergraduate industrial engineers will display and explain the most modern techniques of quality control, industrial plant layout, motion and time study, and production control. Charts, tools, and devices used by the industrial engineer will be available for inspection.

The mechanical engineering exhibit this year promises to be one of the best ever. Every effort has been made to show everything of interest and to present it in such a way that it will be understood and appreciated by everyone.

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XV-1

(Courtesy McDonnell Aircraft Corporation)

Roll out of the XV-1 Convertiplane —first military aircraft of this type ever developed in the United States—was announced today by the Air Research and Development Command of the U. S. Air Force, and the McDonnell Aircraft Corporation. The XV-1 is the first convertiplane in the world to utilize the principle of pressure jets and high disc loading.

The XV-1 is a joint development of Wright Air Development Center of the U. S. Air Force, Transportation Corps of the U. S. Army and McDonnell Aircraft Corporation. The Convertiplane's versatility will permit studies on its tactical use for observation and reconnaissance. Further studies will be made of its design uses as an artillery and tank spotter. An attendant function will be exploration of the application of the convertiplane principle to larger aircraft.

The convertiplane embodies a completely new conception of flight. This new concept is known as the "unloaded rotor" principle—a machine equipped with a rotor for vertical flight and wings and propeller for forward flight.

In vertical flight or hovering, the rotor provides all the lift: in forward flight the wings provide essentially all the lift. This allows the rotor to autorotate at its lowest drag configuration. This avoids the speed limitation encountered by conventional helicopters due to stalling of blades when they must carry lift at high speeds.

Each of the three blades of the rotor is powered by a pressure jet unit located at the tip of the blade. A reciprocating engine is provided on the aft fuselage to supply air to the pressure jet units during vertical flight and power to the propeller during forward flight.

The efficient and relatively great power available from the pressure jets allows the use of a rotor having approximately half the drag of a conventional helicopter rotor. Since the wings do not provide the lift during take-off or landing, they are approximately half the size of the wings for conventional fixed wing aircraft. Therefore, speed performance of the convertiplane is not greatly penalized by utilizing both rotor and wing.

The XV-1 is designed to carry three passengers, or two litter patients and medical attendant in addition to the pilot. The craft is approximately 30 feet long, ten feet high and spans 26 feet in width.

Prior to the first actual flight, which will not take place until next summer, an extensive research program will be required. This will include ground testing, careful instrumentation for the development of flight test data, and painstaking pre-flight test work. The full-scale model will be placed in a wind tunnel to test aerodynamic characteristics.

The convertiplane's tail assembly consists of two vertical fins and rudders attached to the extremities of twin tail booms. The horizontal surface consists of a single stabilizer with tabs, mounted between the ends of the tail booms.

The crew compartment in the fuselage is equipped with large plastic windows which provide exceptionally wide range of vision. Pilot and co-pilot-observer sit in tandem, with removable dual controls provided. Exit doors may be jettisoned in the event of a flight emergency.

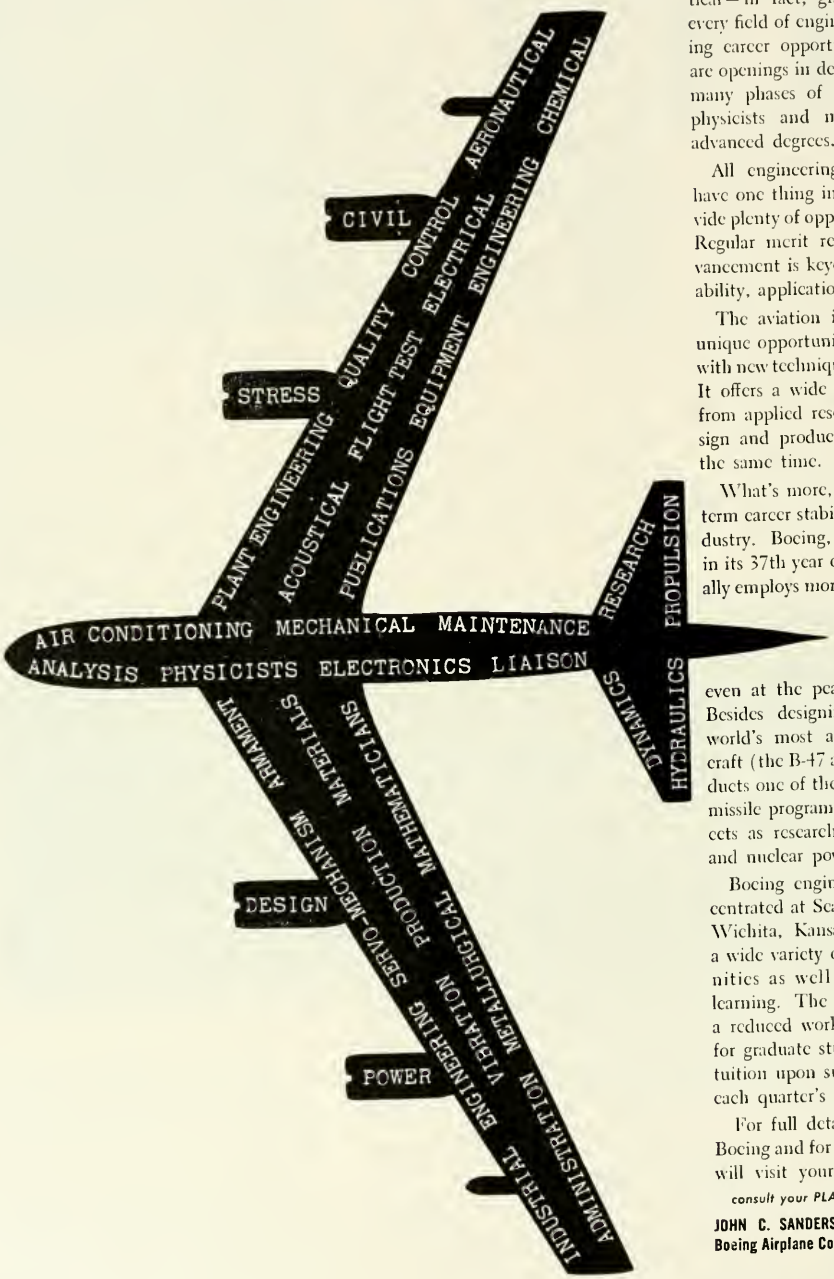
Two non-retracting skids comprise the landing gear of the XV-1. The skid gear differs from previous skids in that energy is absorbed during hard landing by the yielding of replaceable stainless steel straps.

Fuel is fed to the three pressure-jet tip burners through a rotor fuel governor driven from the rotor hub accessory drive. The pressure jets operate on the principle of ignition and expansion of the fuel gases, then exhausting rearward through nozzles to provide thrust. The application of power directly to the blade tips eliminates the torque which in conventionally driven helicopters must be eliminated by the use of a second rotor or propeller.

McDonnell XV-1 Convertiplane

Two gals were stranded in the desert. They were nearly to the point of exhaustion when they spotted a young sailor running from his car to meet them. "Oh," said the cute little redhead to her pal. "We're rescued"—then on second though she said—"or are we?"

Engineers of virtually EVERY type are needed on the Boeing team



Mechanical, electrical, civil, aeronautical—in fact, graduates in virtually every field of engineering—find rewarding career opportunities here. There are openings in design, research, in the many phases of production, and for physicists and mathematicians with advanced degrees.

All engineering careers at Boeing have one thing in common: they provide plenty of opportunity to get ahead. Regular merit reviews are held. Advancement is keyed to your individual ability, application and initiative.

The aviation industry offers you a unique opportunity to gain experience with new techniques and new materials. It offers a wide range of application, from applied research, to product design and production, all going on at the same time.

What's more, you can expect long-term career stability in the aviation industry. Boeing, for instance, is now in its 37th year of operation, and actually employs more engineers today than even at the peak of World War II. Besides designing and building the world's most advanced multi-jet aircraft (the B-47 and B-52), Boeing conducts one of the nation's major guided missile programs, and such other projects as research on supersonic flight, and nuclear power for aircraft.

Boeing engineering activity is concentrated at Seattle, Washington, and Wichita, Kansas—communities with a wide variety of recreational opportunities as well as schools of higher learning. The Company will arrange a reduced work week to permit time for graduate study and will reimburse tuition upon successful completion of each quarter's work.

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consult your PLACEMENT OFFICE, or write:

JOHN C. SANDERS, Staff Engineer—Personnel
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BOEING

A Second Education

What makes a job hold its interest? After working for three years, Wylie Borum, E. E., '50, tells us what has kept his interest alive.

(*Reading time:* 38 seconds)

He graduated from the University of Pennsylvania in 1950, but Wylie Borum's education still hasn't ended. His job, he explains, has become his second education. And this continuing process of learning has kept his job interesting.

Wylie's first year at Bell Telephone Company of Pennsylvania was spent as a student engineer, which he feels was not only educational but extremely worth while. For it was while he took this course that he glimpsed the complexity of the business in considerable detail. He worked in all departments – ran switchboards, climbed poles and even did a stint in the Accounting Department.

Wylie discovered that there were many spots in the telephone organization for engineers besides the General Engineering Department. Even in Accounting – which today is highly mechanized with things like Centralized Automatic Message Accounting Machines.

Training finished, Wylie was assigned to the Manual Equipment Section of the General Engineering Department. His education continued. He found out, he reports, that the dollar is an important part of engineering. In writing equipment specifications, he had to be sure of reasonable cost as well as efficient operation. There's a big difference, he discovered, in doing a theoretical job in school and doing a job in which costs are an important consideration.

Now Wylie has been promoted to the Plant Extension Engineering Group and still is learning. His present job is co-ordinating plans for replacing the last manual central office in Philadelphia with a dial system. The cost will be approximately $1,500,000.

It's a big responsibility. But the Telephone Company puts capable young men on their own quickly.

• • •

Wylie Borum's job is with an operating company of the Bell System. But there are also job opportunities for engineers in Bell Telephone Laboratories, Western Electric, and Sandia Corporation.

BELL TELEPHONE SYSTEM

Better things . . .

Thru Chemistry

by Chuck Evans, Gerald W. Ryan, C. F. Prokop, Dr. R. K. Finn, Ronald Rathber, and Andrew Stebnicki

Rotary Filter

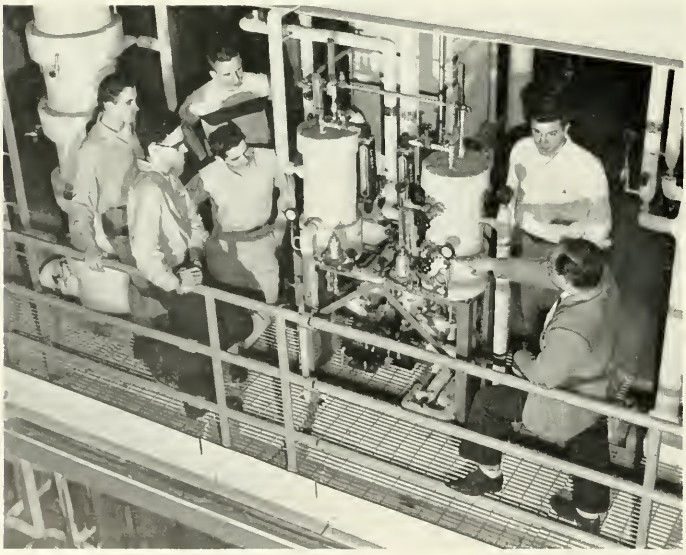
Filtration is the separation of solids from a liquid and is effected by passing the liquid through a porous medium. The purpose of this operation is to obtain the filtrate or solids or both which may be of value in industrial processes.

The broad application of industrial filtration is realized by a survey of industries in which filtration plays an important part: pulp and paper, metallurgy, oil refining, chemical manufacturing, beet- and cane-sugar milling, sugar refining, sewage disposal, cement manufacturing, etc. In many of these processes, filtration is preceded by thickening the slurry, enabling high capacity to be obtained from the filter.

Filtration usually results in the formation of a layer (or cake) of solid particles on the surface of the porous body, frequently a textile fabric, that forms the filtering medium. Once this layer has formed its surface acts as the filter medium, solids being deposited and adding to the thickness of the cake while the clear liquid passes through.

A rotary filter consists essentially of a rotating drum divided into three or more sections with a canvas cloth on the drum surface. A vacuum pump is used to maintain the vacuum in the section of the drum in the slurry by means of a sliding valve mechanism. This removes the filtrate and at the same time deposits a cake on the cloth. The vacuum is maintained as the cake passes a water spray for washing if this is desired. A positive pressure may then be applied by blowing air inside the section of the drum with the washed cake on it. This loosens the cake from the cloth and a stationary blade then removes the cake.

Advantages of rotary filters are that they are continuous in operation, and cheap in operation since no shut-down time is required for cleaning as is the case for some other type of filters.



Chemical Engineering juniors learning the operation of a 6-plate distilling column, in the Unit Operations Laboratory of the East Chemistry Building.

Fluidized Beds

The basic idea that a fluidized bed-fluid passing at a high velocity upward through a bed of solid will support that bed of solids, can be easily understood by most people. If you place your finger in a fluidized bed using an air stream supporting solid beads, the solids in the air stream will feel "wet."

The major industrial use of fluidized beds are in the petroleum industry. A heavy fraction of petroleum, such as naptha, can be broken down into gasoline by contacting the naptha with a solid catalyst at a high temperature. The naptha is pumped at a high velocity upward through the catalyst which fluidizes the catalyst and secures excellent contact between the naptha and solid catalyst.

Bubble Plate Distillation Tower

Distillation is the separation of the constituents of a liquid mixture by partial vaporization of the mixture and separate recovery of vapor and residue. The more volatile constituents of the original mixture are recovered by condensation of the vapors leaving the top of the distillation tower; the less volatile constituents accummulate at the bottom of the tower as a liquid residue.

Rectification (called fractionation in the petroleum industry) is a distillation in which all or part of the condensed vapors at the top of the tower are introduced back into the top of the tower. That is, the liquid passes back down the tower and comes in contact with the vapors rising in the tower. During this contact there is a transfer of both material and heat in which the rising vapors are enriched in the more volatile component. Hence the vapors leaving the top of the tower are more concentrated by this contact than they would have been without rectification or by simple distillation.

An efficient method of securing good contact between the liquid and the vapor in the rectification process is by means of bubble plates. These plates (or trays) are spaced equally in the tower shell. Liquid flows down the tower from

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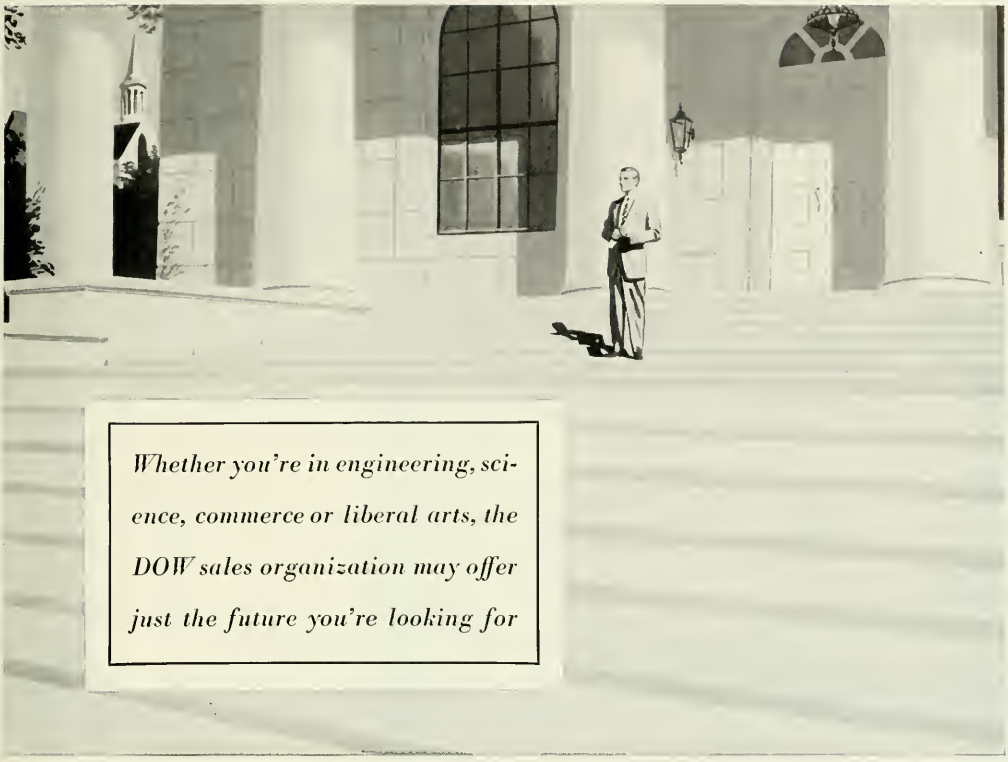

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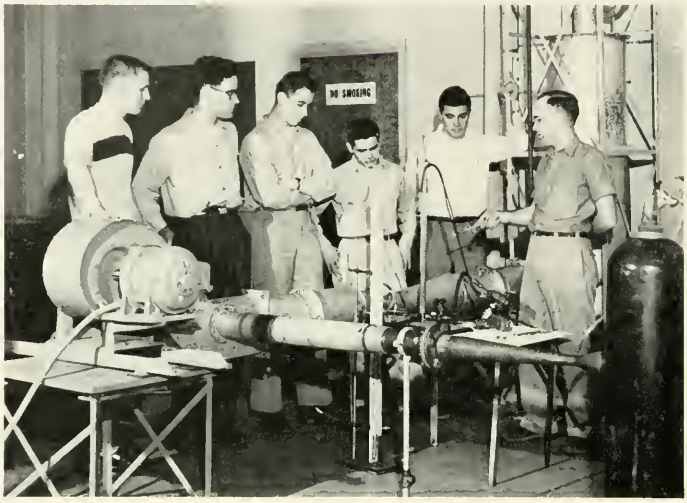
tray to tray through suitable downflow pipes. The rising vapors pass through holes in the bubble plates and bubble up through the liquid standing on the plate. In this way a maximum amount of contact is made and hence a maximum amount of enrichment of the rising vapors is obtained.

A working glass model of a bubble plate rectifying tower is on display in the East Chemistry Building. Bromine is being distilled from a liquid mixture of bromine and carbon tetrachloride. The dark red bromine vapors are readily seen through the glass tower as they bubble through the bubble plates and pass overhead to the glass condenser. We'll meet you there for an inside look at Chemical Engineering.



Explanation of the workings of a Venturi meter apparatus to a group of Chem. E.'s. This apparatus is in the Unit Operations Laboratary.

Liquid-Liquid Extraction in a Packed Column

Liquid-liquid extraction is the process in which a substance dissolved in one liquid phase is transferred to a second liquid phase. This process is carried out by intimately mixing the liquid phase containing the dissolved material with the second liquid which is called the solvent. After the two liquid phases have been mixed together thoroughly, the two phases are separated. The dissolved material is removed from the solvent by some suitable method such as distillation, heating, or cooling to diminish the solubility of the dissolved material. The properties of the solvent greatly determine the effectiveness of the operation. The solvent must be immiscible or only slightly miscible in the first liquid phase since there would be no chance for the dissolved material to be transferred from one liquid to the other if the two liquid phases were completely miscible. The dissolved substance also must have a greater solubility in the solvent.

One method of obtaining the intimate mixing required is the use of a packed column. A packed column consists essentially of a cylindrical tube filled with packing of some kind. The purpose of this packing is to increase the turbulence of the two liquid streams and thereby insure good contact. One of the common types of packing is a saddle-shaped object called Berl Saddles which have a large surface area per unit volume. Extraction columns are usually operated counter-currently which may be explained as follows: consider the case where the feed stream, the liquid containing the dissolved substance, enters the top of the column. In order to be counter-current the solvent stream must enter the bottom of the column. The solvent stream leaving the top of the column and containing a large amount of the dissolved substance is called the extract stream and the stream leaving the bottom of the column and containing a small amount of the dissolved substance is called the raffinate. It should be pointed out that this material referred to as the dissolved substance is usually a liquid.

Liquid-liquid extraction has many useful applications. It is used in the organic chemical industry and in the petroleum industry. It is useful where it is desired to separate relatively non-volatile components or where the components are sensitive to the temperature required for distillation. It is also useful where the desired non-volatile component is present in small amounts.

The Absorption of Gases in Plate and Packed Columns

In laboratories the absorption of gases in liquids is conveniently accomplished by bubbling the gas through a liquid. It is impossible to do this on an industrial scale since the space required would be too long and costs of the operation far too high.

Industry demands that a quick, efficient, simple to operate, and relatively inexpensive device be used. To fulfill the demands the chemical engineer has devised the absorption column. Essentially the absorber produces the same effect that can be accomplished by bubbling gas into a liquid, however, the abosrber does so in a more rapid and more economical manner. There are two streams entering an absorption column. A liquid stream enters the top of the column, the gas to be absorbed enters the bottom of the tower. The liquid flows down through the column by gravity flow, the gas is forced up the column by pressure applied in one of many methods.

The inside of the absorption column can be either packed with a "packing" or have a series of horizontal plates over which the liquid flows and the gases bubble through from properly designed openings which do not permit liquid to leak through.

The "packing" in a packed absorption column may be of many different shapes and sizes. The largest sizes are rarely over three inches in any one dimension. The purpose of the packing or of the horizontal plates is to permit the liquid to flow over a very large surface area. This permits maximum contact with the gas rising up the column and therefore permits the maximum of absorption.

The concentration of absorbed gas in the liquid can be controlled within limits for each absorber by regulating the liquid and gas rates through the absorber.

Bio-Engineering Department

In recent years the application of chemical engineering principles to the field of antibiotics and pharmaceuticals has developed what was formerly only an experimenter's dream to one of the most prolific industries, dollars and cents-wise, in the United States.

Everyone old enough to walk has heard of pencillin. But—did they also realize that engineering development has

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converted the penicillin production from the hand-filled gallon flask stage to the 15,000 gallon "reactor" as an industrial process? Did they know that the engineering aspect has literally "opened the eyes" of chemists and biologists to the potentialities existing in the applications of life's "lower" forms for production of more useful materials? Did they know that penicillin is just one of many "wonder" compounds which have been prepared economically by the once loathed "germs" through the aid of engineering technology.

The exhibit of the Bio-Engineering Department will show a common process which is indicative, even though on a small scale, of the industrial methods and techniques applied to biological processes. The process which will be displayed is the production of gliotoxin, an antibiotic — whose long, silky-white needles have a lethal effect on laboratory animals besides the bactericidal properties—from *Trichoderma viride*, a common mold.

The display will start with a small lump of dirt, from which the mold is isolated and end with a vial of pure, crystalline gliotoxin. The process will show the isolated, pure culture, which will be exhibited microscopically in a Petri dish to show the apparent features of mold growth and macroscopically to show detailed features. Submerged culture tanks will be on hand and a complete Waring Blender ensemble will stress the aeration and agitation of a culture. A simple extracting unit will demonstrate the separation of the antibiotic from the "reaction" mixture. A chart will also be present with informative information on the minimum dosages needed for bactericidal, "animalcidal," and possible "homicidal" injections.

Chemical Engineering Building

The home of the Chemical Engineering Department also contains quite a few surprises for our visitors. Though it may sound unbelievable, an unheard-of public exhibition of the *conversion of energy into matter* will be in operation. Within a few seconds the size and weight of a piece of coal will increase over tenfold. This exhibit is only one of the many awesome displays which will compose a half-hour "Chemical Magic" extravaganza. (Show time—every hour on the hour).

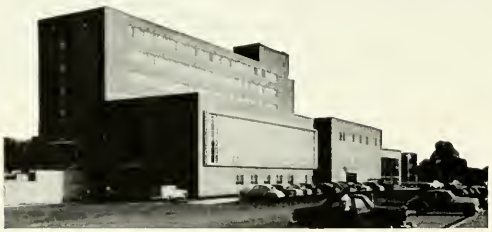
Individual displays of fundamental chemical engineering processes will also be in continuous operation. The treatment of ores prior to their use in chemical processes will be illustrated by the operation of a cone crusher, a jaw crusher, and screening equipment. An absorption column will be operated to illustrate the continuous separation of a mixture of two gases, one of which is water soluble. The continuous removal of solid particles from a liquid will be accomplished with a rotary filter. The separation of two liquids whose near-boiling points make distillation impractical will be demonstrated with a ten-foot liquid-liquid extraction tower. An all glass, bubble cap, distillation column will be operated to illustrate the continuous separation of multicomponent mixtures.

A research project consisting of the study of the three types of boiling in a fluid will be on display. A fluidized bed, another research project will be operated to demonstrate the suspension of a solid catalyst in a fluid as a means of achieving better fluid-catalyst contact.

The geoengineering division of the Chemical Engineering Department will present an exhibit of fermentation processes.

Chemical engineering students will be available to discuss with all who are interested the possibility of choosing chemical engineering as a profession.

The cleanest thing in the world these days is a dollar bill; not even a germ can live on a dollar.



New Student Union Selects Air Conditioning & Refrigeration

This fine building of the Indiana University Medical Center, at Indianapolis, comprises apartments, guest rooms, dining halls, shops, swimming pools, etc.

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BUSINESS AND EDUCATION

by James E. Smith, Ag. E. '55

The problem of support for higher education is one that has troubled thoughtful citizens in a period when tuition fees and income from endowments too often cannot keep pace with mounting costs. The government is a source of aid to higher education; but there are obvious drawbacks to going too far in this direction. Another source, which has not been adequately explored, is private industry. At White Sulphur Springs in mid-November, a special conference planned by Dr. Milton D. Eisenhower, president, Pennsylvania State University, and Robert R. Young, chairman of the board, Chesapeake & Ohio Railroad and of the Alleghany Corp., took up this problem. Before the conference was over, Mr. Young pledged on behalf of the board of Chesapeake & Ohio Railroad an unspecified amount of money to be used in furthering industry support for higher education.

Mr. Young laid the foundation for this conference in February 1953 when, at the 5th annual Barnard Forum in New York City, he proposed closed cooperation between industry and education in an address appropriately entitled, "A Marriage of Business and Education." He again elaborated on this theme on March 26, at the annual dinner of the Federation for Railway Progress in Cleveland.

From this point, Mr. Young and Dr. Eisenhower began specifically to plan the Greenbriar Conference. Dr. Henry T. Heald, chancellor of New York University, and Admiral Ben Moreell (retired), chairman, Jones & Laughlin Steel Corp., agreed to serve as co-chairmen. Dr. Carroll V. Newsom, associate commissioner for higher education in New York State, became conference administrator and Clifford H. Ramsdell, secretary-treasurer of the Federation for Railway progress, served as conference secretary. Educators and industrialists were invited on the basis of size, type, and location of their respective educational institutions and business enterprises. A working agenda was prepared by the conference management.

The objectives of the conference, as one of the co-chairmen put them, were two-fold: first, to discuss and evaluate existing programs of cooperative endeavor between industry and education; and second, to consider on the strength of demonstrated mutual benefit from already established programs, how they could work together further "to preserve, protect, and enhance the values of a free system of competitive enterprise and a democratic way of life."

The two day meeting started with a general session and talks by Mr. Young, Dr. Heald, and Admiral Moreell. Then six small work groups considered these four subjects:

1. Cooperation in providing improved educational opportunities for young people.

2. Cooperation in providing expanded educational services for industrial employees.

3. Greater effort on the part of industry and education toward an understanding and resolution of the problems of mutual importance.

4. Next steps to increase the number and total effectiveness of cooperative efforts by industry and education.

By the time the conference closed, seventy presidents—half from industry and half from education—were substantially agreed on these points:

1. That better communication, by direct contact, is needed for each to understand the problems of the other.

2. That support for education by industry will be a natural consequence of further cooperative efforts in projects of mutual interest.

3. That additional similar conferences should be held on regional, state ,and local levels throughout the country.

4. That educators and industrialists should meet and work together whenever possible on a person to person basis.

5. That a national agency should be set up to act as a service bureau for future conferences, serve as an information clearing house, and function as a publicity organization.

6. That, while presidents of universities and presidents of business organizations may agree fully, college faculties, on the one hand, and directors and stockholders, on the other must be convinced of the mutuality of interests of education and business, and be willing to help further it in word and deed.

7. That, while cooperation in technical research is well established, there is need to "build a better bridge" between industry and higher education in the social sciences, humanities, and liberal arts.

8. That more educational programs should be geared to industry's direct and immediate needs, and, at the same time, that industry should contribute more freely and fully to the general needs of educational institutions.

9. That in corporate giving, where there is a will, there's a way; that corporate aid should be considered not as a gift or a grant, but as a "factory expense," that is, as a cost of doing business.

10. That there should be wider use of scholarship programs, work-study plans, guidance services, in-service training, short courses, seminars and conferences, exchange personnel (college professors working for industry, industrial personnel as temporary faculty members), research projects, and direct gifts to groups of colleges or to individual colleges.

The need of industry for specialists is obvious. Less obvious, but not less important, is industry's need for men and women who can think clearly and independently and who have sensed deeply the values upon which a free society rests. Admiral Moreell made it clear in speaking at the conference that the liberal arts are as much a part of the background of a sound industry as are the sciences. The problems in the way of grants by corporate institutions to higher education are admittedly considerable; business has to make sure that the interests of its stockholders are really being served and the colleges have to make sure that their traditional freedoms are in no way impaired. The fact that representatives of both interests have come together to work out these problems is encouraging; for this field seems to be one where, if the will exists, a way can certainly be found.

The Civil Engineer

—CREATOR
—DESIGNER
—BUILDER

by Robert M. Koscielny, C.E. '54

The civil engineer is responsible for the design, construction and maintenance of buildings, highways, railroads, bridges, dams, airfields, canals, water and sewage systems, harbors, tunnels and surveying. Since civil engineering covers such a broad field the department is broken down into options. These options include: Structural Design, Highways, Railroads, Construction and Sanitary Engineering.

Structural Design—It is the structural engineers duty to design bridges, buildings and many other types of structures so that they may perform their proposed service with the most economical and safe proportioning. The actual designing involves first, determining the forces or loads which the frame will be required to support; second, arranging a system of beams, columns, and tension members in various forms and combinations to support the proposed construction adequately; third, calculating the direct stresses, shears and moments, caused by the applied loads, in members of the frame fourth proportioning the members to resist safety and economically the forces to which they are subjected.

Most of the undergraduate work in structural design is done in Civil Engineering Hall, however, a large structural laboratory for testing, research, and instruction is located in Talbot Laboratory. The information obtained in the laboratory and elsewhere serve as a basis for better knowledge of the behavior of structures and to the development of more economical and efficient design of engineering structures. At present the following tests are being conducted mostly by graduate students in Talbot Laboratory.

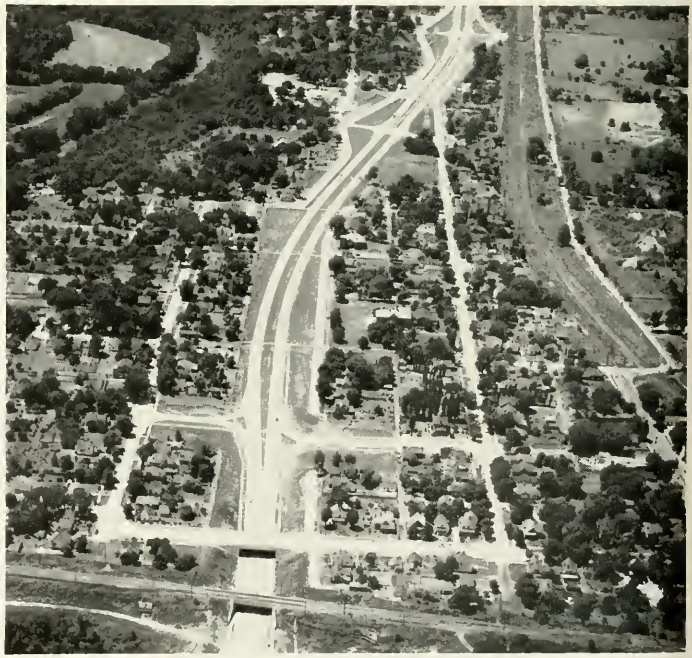
1. *Riveted and Bolted Structural Joints*—This program is concerned with the strength of structural steel joints made with rivets or bolts, and subjected to static or repeated loads until failure. A second phase is concerned with the effect of the rivet pattern or arrangement on the strength and efficiency of the joint. Still another phase of the program is concerned with the strength of bolted structural joints. It has been found that high-tensile strength bolts provides a connection which in most cases is superior to similar riveted connections.

Fatigue Strength of Welded Connections—The objective of this program is to determine those welding variables which affect the physical properties of a welded joint, how the properties are affected, and to apply this knowledge to the improvement of the arc welding of structural steel.

Prestressed Concrete for Highway Bridges—The objective of this project is to obtain information so that the structural engineer may utilize prestressed concrete to the maximum possible advantage. The experimental work in this investigation has involved tests on simple beams to determine their bending and shearing strength.

These tests will be in progress during Open House and you are urged to come and examine the testing equipment and methods for yourself. It seems necessary to point out that the results of these and similar studies increase the engineers understanding of the behavior of structures under different conditions of loading and provide the basis for more efficient and rational design methods.

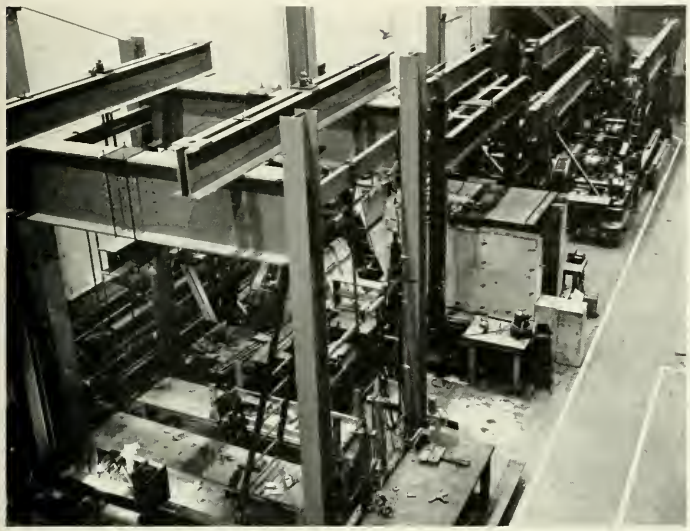
Highway Engineering—It is the duty of the highway engineer to design, layout, and supervise the construction of highways. In the design much consideration is given to traffic volume and the type of loading to which the pavement



Modern dual expressway under construction from Danville to Peoria

may he subjected. Since the support and stability of the highway slab are obtained directly from the material beneath it, considerable attention is given to the soil underlying the pavement. The highway engineer uses the soil tests a. demonstrated in room 201 Talbot Laboratory to determine the stability and other characteristics of the soil. Drainage is another variable which affects the stability of this soil and it is the highture tests of driving skill, eye sight, and reaction time for those visitors who wish to test their skills.

Railroad Engineering—The railroad engineer as the highway engineer is concerned with the design, layout and supervision of construction of railroads. The terminals and intermediate points connected by a railroad are determined by its promatirs with a view of the amount of traffic that can be expected



Laboratory for testing concrete structures and bridge frameworks

way engineers job to see that adequate drainage is maintained.

In laying out highways the highway engineer must consider existing terrance traffic volume, traffic flow and speed. The highway engineer uses traffic counts to layout particular intersections and to determine the most used routes. The highway engineer is not limited to highway planning, in fact, his major and most complex problems are those concerned with municipal streets. For municipal work he must coordinate stop lights, design intersections, and expressways to prevent the jamming up of traffic and maintain a steady flow of traffic at all times.

The highway engineer also must supervise the construction of highways in order to insure good materials and workmanship. He is responsible for designing concrete or asphalt mixes and finally testing these materials to be sure that they meet the required specifications.

Since surveying is so closely connected with highway work, the surveying equipment used by all civil engineers is exhibited along with the highway exhibits. The highway engineers exhibit will feafrom them. From the nature and amount of traffic and the direction of the heaviest haul, the railroad engineer determines the maximum gradients and curvature advisable. Aside from this his problems and duties nearly parallel those of the highway engineer. A model and a series of photographs will be featured as a part of the railroad engineering exhibit in Civil Engineering Hall.

Construction—The construction engineer has general control of all construction operations. He studies the different types of construction equipment and their uses and limitations. He must select the proper size and amount of equipment, materials, and personnel to perform the operation in the quickest most economical manner. He sets up construction schedules and plant layouts for field operations. He also must estimate construction costs and be familiar with cost accounting and legal contracts documents.

This year's construction exhibit will include a model of an actual construction operation in progress. Many new types of construction equipment and methods will also be exhibited.

Sanitary Engineering—The principle duty of the sanitary engineer is the design and operation of municipal water supply and sewage treatment plants. The Sanitary Engineering Laboratory is equipped to conduct tests in the field of sanitary engineering, including water supply, distribution, and purification; sewerage and sewage treatment; and stream pollution. The sanitary engineer must design pipe lines, reservoirs, pumping machinery, and distribution systems to handle the required amount of water or sewage.

The sanitary engineer spends much of his time in the Hydraulic Engineering Building which is equipped to carry on model research projects in drainage, open channel flow, pressure flow, orifice discharge, spillway discharge and other features pertaining to the design and construction of hydraulic structures. A thorough understanding of hydraulics is a basic requirement of the sanitary engineer.

A model sewage treatment plant built by the sanitary engineering students will be displayed in Civil Engineering Hall. The Sanitary and Hydraulic Engineering Laboratories will also be open and you are invited to visit them.

The field of civil engineering is broad and the opportunities are unlimited. The students, and faculty are proud to exhibit to you the largest, most well equipped College of Civil Engineering in the country.

From Wash. State *Symbol*: Wo. Thought to be a member of the human family.

At. Wt.: Accepted as 120, though known isotopes vary from 100 to 180.

Occurrence: Found both free and combined, usually with man.

Physical Prop.: Seldom found in pure state. All colors. Surface usually protected by a film of paint. Boils at nothing and freezes without reason. An unpolished specimen tends to turn green in the presence of a highly polished one. All varieties melt with proper treatment. Density not as great as once supposed.

Chem. Prop.: Highly explosive and dangerous in inexperienced hands. Possesses great affinity for gold, silver, platinum, and all precious stones. May explode spontaneously when left alone by man. Fresh variety has great magnetic attraction. Ages rapidly.

Uses: Chiefly ornamental. Cleaning agent. May produce fever. Most powerful reducing agent (bank accounts) known.

"Don't talk to me about lawyers, my dear. I've had so much trouble over the property that I sometimes wish my husband hadn't died."

PROGRESS OF A PROBLEM

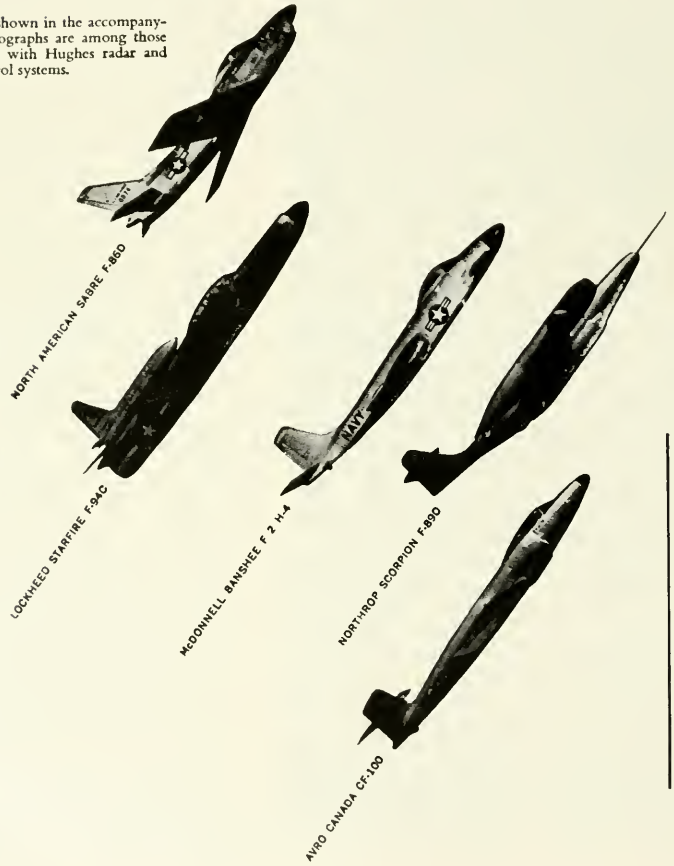
THE PROBLEM:

To design and manufacture advanced radar and fire control systems for military all-weather fighters and interceptors—equipment that must be light in weight, versatile, and capable of accurate operation day or night under extreme conditions.

At Hughes the answers to these requirements for complexly interacting systems involving advanced radar and fire control have been under continuing development from *1948* and in production since *1949*. Even more advanced systems are currently in process of development for supersonic aircraft.

Beginning with systems engineering and analysis, the military studies are initially concerned with evaluation of the strategic and tactical needs of the services in order to establish design objectives. This is followed by the analysis of problems involving noise, smoothing and prediction, multi-loop nonlinear servos, aircraft dynamics and controls, and the properties peculiar to conversion of analog information to digital quantities. From the analytic stage evolve the requirements for systems design and circuitry, designs of computing sub-systems, microwave transmitting and receiving equipment, the presentation of information to an airplane pilot, and advanced testing needed to optimize over-all system performance.

Aircraft shown in the accompanying photographs are among those equipped with Hughes radar and fire control systems.



SYSTEMS ENGINEERS

CIRCUIT ENGINEERS

Further advancements in the fields of radar and fire control are creating new positions on our Staff for engineers experienced in the fields of systems engineering and circuit design, or for those interested in entering these areas.

SCIENTIFIC
AND
ENGINEERING
STAFF

HUGHES

RESEARCH AND DEVELOPMENT
LABORATORIES

Culver City, Los Angeles County
California

Good climate for **engineering** jobs!

The finest research and engineering facilities are available to International Harvester engineers. Here they test truck performance at 70 degrees below zero.

■ The American transportation system is the most highly developed in the world. And International trucks are part of this picture.

At Fort Wayne, Indiana, International Harvester maintains the biggest truck research, development and testing laboratory in the world. The opportunity such an operation provides for young engineers is obvious.

Throughout the entire International Harvester operation, engineers are needed. Electrical, mechanical, industrial, metallurgical, agricultural, design, research, and testing engineers find that Harvester offers unusual opportunity.

If you are interested in a career in the engineering field, we suggest you write to F. D. MacDonald, Education and Personnel Department, International Harvester Company, 180 N. Michigan Avenue, Chicago 1, Illinois.

INTERNATIONAL HARVESTER

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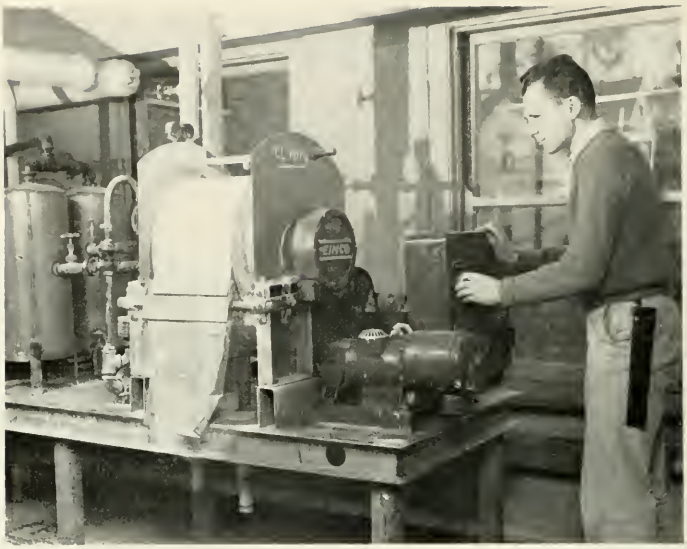
Builders of Farm Implements and Farm Tractors for easier, more profitable farming . . . Trucks for better transport . . . Crawler and Industrial Tractors . . . Industrial power for road-building and earth-moving . . . Refrigeration for better preservation of food

TICKLE YOUR CURIOSITY

. . . There'll be a Hot Time in the Physics Building

by Alan Blankfield, E. Phy. '54



Carl Vinson, '55, examines a pulverizer in the crushing and grinding room of the East Chemistry Building.

The second World War has come and gone, leaving in its wake many pock marks on the face of society as a whole, and in many cases effecting irrevocable changes in landscape and human masses which are truly monuments to our ignorance and emotional immaturity. Yet, rising from this quagmire of human disgrace, came technological advances which were far and beyond that which we produced during peacetime and prosperity. This fact also exemplifies man's intolerance toward and lack in regard for his fellow man. Be that as it may, this is not a paper to cry out against human injustice; nevertheless, I feel it should be noted that it was from that cesspool of human relations that the physicist and the engineer emerged with a new insight as to the needs of the other in particular and of the nation in general.

Thus was formed, soon after the recent conflict, a new animal, an Engineering physicist by name, whose job it was to fill the larger gap that had grown between the two respective branches of science. Somehow more physics had to be learned by the engineer and more engineering by the physicist. But, as soon became evident, neither curriculum had enough space for the proper treatment of its own subjects in four years, let alone the adequate inclusion of the other. This was the dilemma which faced our educators at the war's end. It was met by starting this new curriculum in a few of our major universities which allowed for a program of advanced mathematics, advanced physics along with an engineering technical option, to the mutual exclusion of humanity and civilization courses.

This style of education did not meet with unanimous approbation among our educators; in fact, the Engineering Physics curriculum as yet has not been adopted by many of our big schools, notable among them are: Columbia University, and the Massachusetts Institute of Technology. They still contend that it is not the function of a university to furnish to the world well-trained and highly-skilled technicians, whose formal education in the fields of humanities is nil; but it is to pour forth from its portals of knowledge, human beings, with well-rounded educations, who are capable of assuming an integrated and balanced place in society as well as being skillful in their respective fields. This is a major controversial issue as yet unresolved, with many profound facets, which I leave to the reader to think about; for this paper's main concern is the physicist's role in the 1954 Open House.

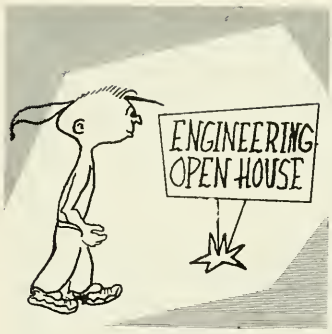
We have for you this spring quite a varied collection of exhibitions, lectures, and the like for your enjoyment. Physics' contribution will include displays from each of the following six categories, namely: heat, sound, light, electricity and magnetism (which includes an electronics display), atomic and nuclear physics, and mechanics. A seventh attraction will be a lecture on space flight which will be continuously given; and

last to be mentioned, but by no means last in importance, is the lectures that will be given downstairs in the Engineering Research Building, on the Illiac, the University of Illinois' prized high-speed computer.

Since I mentioned heat first, I'll start describing our exhibits by telling you what Gordon E. Cash's people are going to do. Gordon, who is a junior in Engineering Physics, is chairing the group, and his main subject is the design and construction of an amazing device called the Hilsch Vortex Tube which seems in essence to separate low and high speed gas molecules. I know that this sounds like a violation of the second law of thermodynamics, but contrary to its appearance, it does not do so. Dr. Hilsch, its inventor, had a time with the intricacies of the theory, and was first troubled by this apparent violation; but later an adequate qualitative description of the tube was given. Up until this printing no exact analysis has been found. This is one display that should tickle your curiosity. Other exhibits will include a demonstration of low-temperature physics, where a super-conducting bar of metal will be made to float on a magnetic field, along with other unusual cold-lab experiments. If all goes well, there will be induction heater set up in which metals will be melted before your eyes without any semblance of a flame.

Next on the list is the sound group with two chairmen, rather one chairman, Alan C. England, Eng. Phys. '54, and one chairlady, Miss Gloria Winkel, Eng. Phys. '54. This pair of seniors have a weird electro-musical device rigged up, where-by, the pitch and volume of the sound can be continuously varied thru the different placement of one's hands with respect to two antennae. This instrument, called the Therimin, has its practical use also, as it is part of the stock and trade of radio sound-effect men and was heard as the solo instrument in the background music of the motion picture "Spellbound." Several of our people are learning to play this instrument and a good time should be had by all. Another display will be the picturization of your voice pattern on the screen of an oscilloscope.

The light people are headed by a man familiar to most, Bob Trapp, Eng. Phys. '54, who is also the chairman of Engineering Council. Even though these are light people, they are certainly not light headed, for the displays that they have set up took some deep thinking. Their main attraction will be a sound modulated light beam with which sound communication will be carried on across a room over a beam of light. Other exhibits will include the bending of light thru a water stream and some experiments in polarized light.

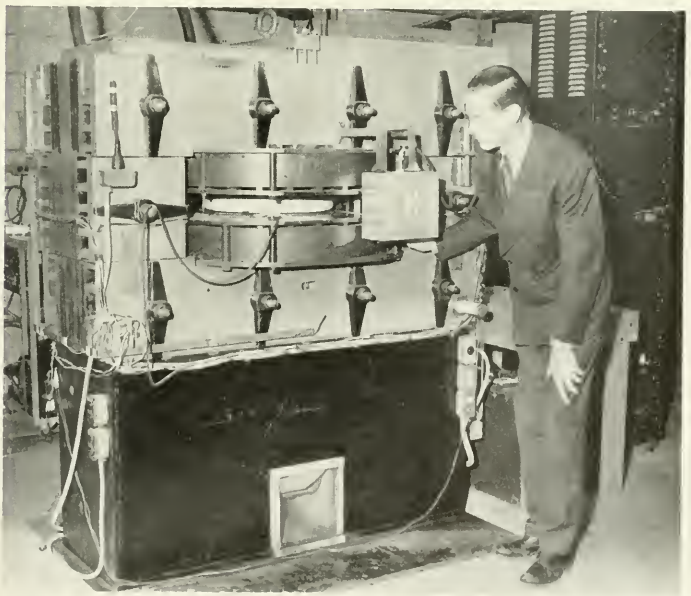


Joseph M. Berstein, Eng. Phys. '55, will let you benefit from his experience in the field of electronics by chairing the electricity and magnetism group. This group proudly displays a simulated flying-spot scanner, which the fellows designed and built themselves. This scanner will "read" any geometrical figure or even your own name written on a glass slide, and will then electronically display it on an adjoining oscilloscope. Accompanying this exhibit will be one consisting of several high-voltage demonstrations including ones with audience participation. This group promises to make their show a real shocker.

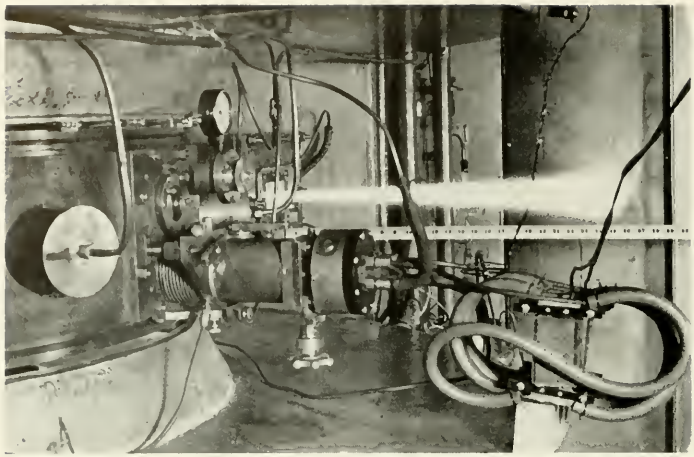
The experiments in nuclear physics, which were so popular in the last Open House, will be repeated again this year for all to enjoy. Ronald Lambert, Eng. Phys. '55, will head the group this year and has added many new nuclear and atomic wonders for you to behold. Says Ron, "There'll be a 'hot' time in the old Physics Building tonight." Alright Ron boy, we understand, hmm, hmm, sure, yes we'll see you there. Bye now.

I think that one of the highlights of our show, or at least so the audiences thought in preceding years, is our mechanics exhibit, headed by Miss Donna Rudig, Eng. Phys. '57. They have a fairly frictionless table on which they'll take you for a spin. But, I warn you, you best wear a crash helmet and strap your safety belt down tightly, for this group really sends you. Man, they're real gone. Included is also a wild-eyed pendulum that fairly knocks you right from your seat. I predict that this is an exhibit that will set the joint a-rockin' for you and make the stout of heart go running for their vitamin pills.

In accordance with the precedent set last year, we will have another full lecture, only this time it will cover the topic of Space Flight. We are very fortunate in securing a non-physics student, Arnold Dipert, a lawyer, whose vast knowledge on the subject will soon become apparent as you listen to him. Arnold got interested in proposed rocket travel as a young boy, and many say that he has been in the clouds ever since (in a fog that is). His lecture will be augmented with a series of slides depicting



Prof. D. W. Kerst of the Physics Department is shown with the 30 mev betatron which he developed here at the University of Illinois.



Ten mev deuterons emerge from the U. of K. Cyclotron. (Photo courtesy of Nuclear Rodiation Loboratory)

the surface conditions on the various planets. Your experiences in Open House will be made much richer thru attending one of Arnold's lectures.

We are very honored in having the Illiac with us this year. Dr. Meager, who is the director of the computer staff, has graciously allowed computer time for demonstrations which will occur for 15 minutes at the beginning of each hour. As you all know, the Illiac has become an important tool in the research that has transpired on this campus, and there is a constant search being made at the Computer Laboratory in order to find new and speedier ways of utilizing this powerful tool. I am sure that you will find the visits to it shall be instructive as well as entertaining.

Thus we have come to the end of the Physics Society program. This however, has only been a limited sneak preview of the new and exciting things that are in store for you when you come and taste of our wares at the 1954 Engineering Open House.

Technocracks

• •

A Communist agitator rode into a city park, and after leaning his bicycle against the railing, mounted a soap box and addressed the crowd.

"If your family is hungry," he shouted, "raid a shop and take food for them, and don't care what anybody says. If your wife hasn't a coat, take the best fur coat you can see, and ignore the consequences."

After several more minutes in this type of talk, he dismounted from the soap box, and his next words were "Where's the scoundrel who took my bicycle?"

* * *

Mrs. Simpkins: "Listen to me, I'm sick and tired of hearing you talk about 'my car' and 'my furniture' and 'my son.' It's getting on my nerves and you are going to learn to say 'our.' What are you looking for now in that closet?"

Mr. Simpkins: "Our pants."

* * *

Well we know you all aren't two faced or you wouldn't go around wearing the one you have on now.

* * *

Lady: "Could you please tell me where I'll find some silk covering for my settee?"

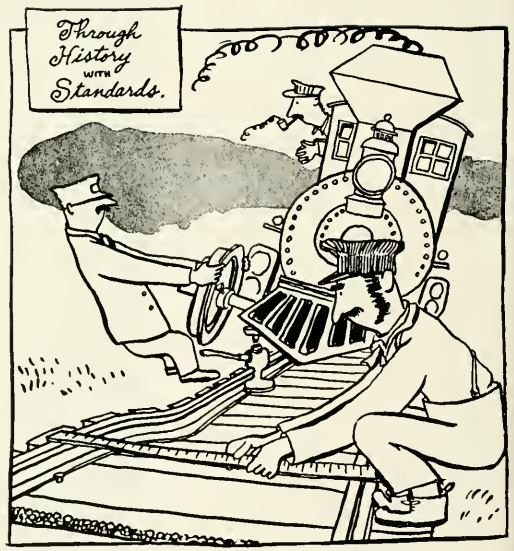
New Floorwalker: "Two aisles over, Ma'am, for the lingerie department."

How the Railroads Standardized Their Track Gages

Standards engineers agree that probably the most important group standard ever developed in the U. S. was the railroad's standard track gage and system of interchangeable brakes and couplings. These standards make possible the interchangeability of rolling stock among virtually all roads throughout the nation.

Most of the early American railroads had their own gages, the changeover to the present standard gage being made about the time of the Civil War. At one time President Lincoln issued an order that the gage should be five feet. This never became effective, and after many consultations between the roads the present gage of 4 feet 8½ inches became universal.

This standard gage is used in Britain, the U .S., Canada, and most of Continental Europe, India and most of the important railroads in South America use 5 feet 6 inches. South Africa uses 3 feet 6 inches. Australia has never adopted a standard gage, and when cargoes are transferred they have either to be reloaded or special undertrucks have to be used.



Around the ancient track marched, rank on rank,
The army of unalterable law.

—MEREDITH, Lucifer in Starlight

How to Attract and Hold Engineering

TALENT

edited by P. E. LaViolette

The following article is a report on "Executive Research Survey Number Three: How to Attract and Hold Engineering Talent." The survey was prepared by the Professional Engineers Conference Board for Industry in cooperation with The National Society of Professional Engineers.

American industry again this year is eyeing college campuses across the nation for the young man who soon will be tucking that new engineering degree under his arm.

And in June industry will once more be vieing for his talents, making him offers the fledgling engineer has never before received in history.

This is a rosy outlook for the young engineer, but it has a "catch." That is that some graduates—a sizeable number to be sure—are going to be "oversold" by eager employers on what the rookie engineer can expect on his first job.

When the "honeymoon" is over a lot of engineers will find themselves bending over a drafting board or in testing, analysis or computation assignments. Then they may start wondering why management is not using to the fullest the talents for which there was such frantic bidding only a few months before.

This is the picture given by engineers who were caught up in a similar campus employment rush during the past few years—a picture presented in a report to industry on "How to Attract and Hold Engineering Talent," prepared by the Professional Engineers Conference Board of Industry.

Today, nearly 40 per cent of employed engineers are unhappy in their jobs, the report shows, and many of them blame their discontent on the fact they were "oversold" by industry recruiters.

On the other side of the picture, are the many engineers who have found satisfaction in their jobs. And equally significant is the way in which a wide section of industry is doing everything at its command to keep the engineers happy.

What the engineer thinks of his job and what industry thinks of the engineer—a story which may go far toward achieving sounder understanding between the two—is revealed in the report.

This report is based on a survey carried out to learn how management can best create a climate in which its engineers can work, happily and effectively, in an employee capacity while still retaining professional attitudes. More than 1,400 engineers employed in industry and more than 200 employers of engineers—executives of companies which carry on their payrolls more than 1,000,000 persons, working in 1,428 plants—participated in the survey.

If such a large percentage of engineers aren't happy, what's the reason? Some say they think their salaries are too low and some blame it on lack of opportunity for advancement offered by the employer.

Of significance, however, is the fact that twenty-eight per cent of all the engineers queried—including those satisfied with their jobs—indicated some colleges are not training them adequately for a career in engineering. And a large number of executives agree. Eighty-eight per cent of the employers felt engineering schools are turning out graduates with an adequate background of knowledge of scientific fundamentals, but a majority (62 per cent) believed these newcomers were sorely dificient in other areas of study.

Engineers and executives alike were agreed on where these deficiencies lay. Thy indicated a need for more work in English, the social sciences and business administration. One executive put it this way: "They (the engineers) know the engineering principles thoroughly. But they do not know how to put their ideas into words, either orally or on paper."

How important this lack of adequate preparation was regarded by some is clearly shown in the survey results. Those who pointed to a poor engineering background in college made up the bulk of the group which expressed dissatisfaction with their lot in industry, particularly as regards their prospects of future adavancement.

The vice president of a Philadelphia transportation firm probably put his finger on the problem when he explained: "Too many of our engineering schools have become so overspecialized as to be not much better than trade schools."

The engineer, like the doctor and the lawyer, is a professional man. Professional status, he feels, places him in a class certainly above that of the ordinary skilled worker. But what about his professional attitude? Here, he has let himself down and he alone is to blame, the executive group believes.

Sixty-two per cent of the employers questioned said they thought the young engineers' attitudes are unprofessional. In one plant a management representative complained that many of the engineers do not think of themselves as "working for the company" but have the attitude that the company, as one put it, "is a laboratory operated for their own special benefit."

In his own defense the engineer tosses the blame right back at his boss. Twenty-nine per cent replied they did not feel their companies recognize their professional status. They resent being treated "just like any other employee."

Many companies have recognized the need for pointing up the professional status of their engineering employees and in this way have made great strides in achieving a common ground of understanding. For example, they encourage their engineers to accept membership in professional societies and participate in technical, cultural and civic activities, both for the professional growth and social contentment of the engineer and for the public relations benefits which accrue to the company from such activity.

A common complaint among many engineers questioned in the survey is that they don't know where they "stand" with the company. This, they believe, eliminates a basic feeling of security on which so much emphasis must be placed.

Both the executives and the engineers were asked if the latter were kept currently informed of their personal progress within the company. Eighty-five per cent of the executives answered in the affirmative, but fifty per cent of the engineers said "no." Proof that the engineering employee wants such a progress report is the fact that more than three-fourths indicated a desire for a merit rating system.

It was made quite clear that something should be done, and quickly, about the curriculums of many of our engineering schools . . . that engineers should

be required to carry more English, and social studies and the "humanities" . . . that, in short, those schools which have narrowed their curriculums to exclude, or dismiss with a modicum of attention, nearly everything, apart from purely vocational work, had better start turning out not merely engineers, but educated engineers.

Needs which were indicated in the report are:

1. Readjustment of salary scales to provide more equitable compensation for the engineer who has been in industry for a number of years and who now finds that the pay raises aren't coming as fast as might have been indicated by the fat starting salaries.

2. A new approach to campus recruiting, with a more realistic presentation of the industrial facts of life to the job candidate, who today frequently is "oversold" on the job and soon loses interest because it doesn't come up to expectations.

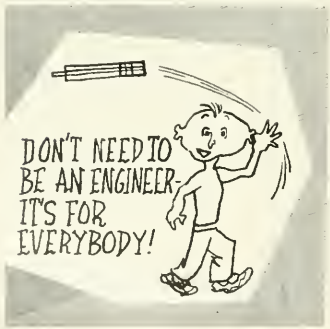
3. Differentiation in personnel policies as they apply to engineers and to non-professional employees. (Sixty per cent of the employers said they treated all employees the same.)

4. Encouragement by management of engineer participation in such prestige activities as writing and lecturing on technical subjects and participation in professional society and community affairs.

5. Improvement of engineer-management communications, both upward and downward, as recommended in Executive Research Survey Number One: "How to Improve Engineering-Management Communications."

6. Increased employment of supporting, sub-professional personnel for routine assignments to relieve engineers for purely engineering work, as recommended in Executive Research Survey Number Two: "How to Improve Utilization of Engineering Manpower."

7. Increased activity on the part of the professional societies towards the stimulation of professional attitudes not only among their own membership but among all engineers.



MY BOSS

The Engineer Says—

Average age . . . . . 35 years
Average length of time employed by company . . . . . 6-8 years
Average length of time in engineering profession . . . . . 9 years

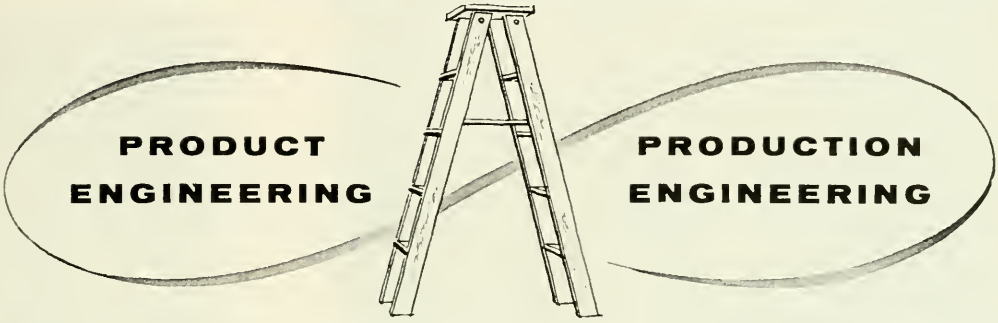
1. Do you feel now that your collegiate training prepared you adequately for an engineering career?
   YES 72%
   NO 28%
2. Are you satisfied with your present job with respect to
   a. Salary
      YES 55%
      NO 45%
   b. Prospects
      YES 66%
      NO 34%
   c. Nature of work
      YES 84%
      NO 16%
   d. Working conditions
      YES 83%
      NO 17%
   e. Location of work
      YES 87%
      NO 13%
3. Do you feel your company is making effective use of your training and ability?
   YES 62%
   NO 38%
4. Are you kept informed of your personal progress in your job?
   YES 49%
   NO 51%
5. In which of the following "prestige" activities, if any, does your company encourage you to participate?
   a. Writing for technical publications 24%
   b. Teaching or lecturing on engineering subjects 16%
   c. Participating in community affairs 38%
   d. Participating in professional society activities 54%
   e. Other 6%
6. Which of the following best describes the nature of your job?
   a. Entirely engineering activity 37%
   b. Partly non-engineering activity. What part? 41% 60%
   c. Wholly non-engineering activity 3%

The Executive Says—

Type company executives answering:
   a. Heavy industry (steel, etc.) 7%
   b. Manufacturing 48%
   c. Governmental services 8%
   d. Public utility 6%
   e. Other 31%

1. Do you feel that engineers you employ directly from colleges have adequate
   a. Knowledge of the fundamentals of the engineering science?
      YES 88%
      NO 12%
   b. Professional attitudes
      YES 38%
      NO 62%
2. Does your company offer special training programs to fit your junior engineers for better positions?
   YES 45%
   NO 55%
3. Does your company make any distinction between procedures applying to engineers and those for non-professional employees?
   YES 40%
   NO 60%
4. Does your company keep its engineers informed of their personal progress as well as of their deficiencies?
   YES 85%
   NO 15%
5. Which of the following "professional prestige" activities does your company encourage its engineers to participate in?
   a. Writing for technical publications 26%
   b. Teaching or lecturing on engineering subjects 16%
   c. Other 2%
   d. Participation in community affairs 24%
   e. Participation in professional society activities 32%
6. Among those engineers who have left the employ of your company within the last two years, what, in your opinion, were the chief causes of their dissatisfaction?
   a. Insufficient salary 33%
   b. Lack of professional recognition 9%
   c. Boredom with routine work 11%
   d. Lack of opportunity for steady advancement 12%
   e. Feeling of insecurity 7%
   f. Location of work 14%
   g. Personality clashes 14%

TWO MORE WAYS TO CLIMB THE GM JOB LADDER



When considering your first engineering job—ask yourself this:

What kind of person am I? The kind of person who likes to *invent* things—or *design* them?

The kind who likes to be in on the *birth* of an idea? Or the kind who likes to meet the challenge of new designs, new inventions, new ideas — by figuring out how to *build* them in quantity at a price to make them available to the greatest number of people?

For — the first type is bound to be happiest as a *Product* Engineer; the second as a *Production* Engineer.

In Product Engineering, GM offers you a successful career whether your interest lies in automotive or Diesel engineering, design, fuel and plastic research, or creating new beauties of motorcar styling.

In Production Engineering, GM also—as has been proved by its success in mass production of fine products—is a leader in manufacturing processes and production techniques, with all the fine career opportunities that this implies.

And the same goes if you have your sights fixed on Research, the exciting hunt for knowledge in the field of applied science — or if you're contemplating a career in Plant Engineering, the planning, developing, installing and maintaining of GM plant equipment and services.

Yes, there are *all* kinds of opportunities for the graduate engineer who has what it takes to climb the GM job ladder.

GM positions now available in these fields:

MECHANICAL ENGINEERING
METALLURGICAL ENGINEERING
CHEMICAL ENGINEERING
ELECTRICAL ENGINEERING
INDUSTRIAL ENGINEERING
BUSINESS ADMINISTRATION

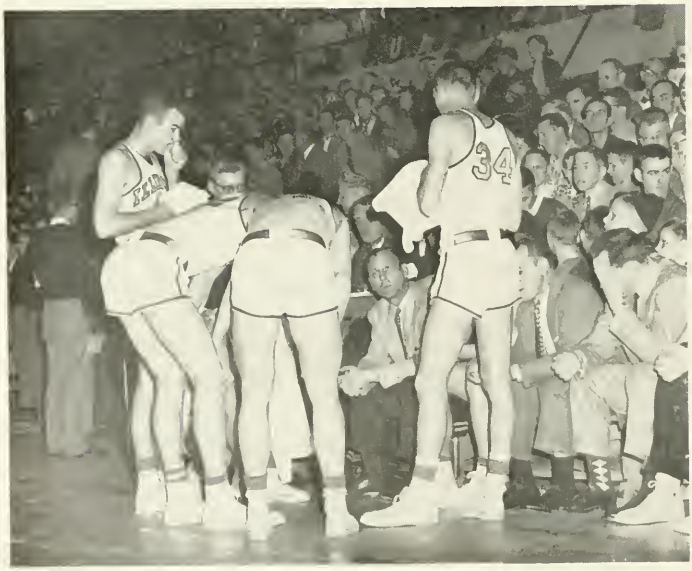
GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

Combes'

Jimmy Wright goes up for o hook shot during the Iowo game

Hero Wright is hoisted by his tea



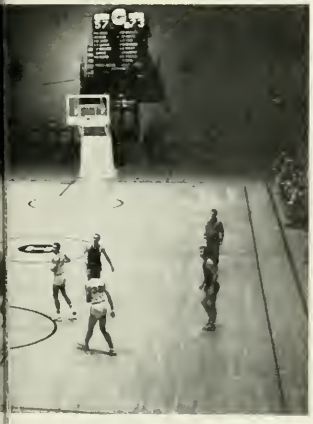
Cooch Combes sweats it out in huddle

OOPS! That's not

—Photos by Frank Slef

Cagers

tes after the Wisconsin game



of our boys!

and Tucker Nason

Everyone is tense while Captain Kerr shoots his second free throw

Don't fight, Mokovsky's got the ball!

NEEDED--- A NEW APPROACH!

HE HAD ONE

McDonnell engineers have again demonstrated their pioneering spirit. The problem—how to land a speedy, transonic airplane—normally requiring a mile or more of runway—in the short space available on an aircraft carrier deck. This is but one of the many complex problems successfully solved by M. A. C. engineers in developing the new Navy F3H Demon, now in production.

Youthfulness is another characteristic of this progressive engineering team, the average age being under thirty. Engineering graduates find working with men of their own approximate age group greatly facilitates getting acquainted and gaining that "feeling of belonging" more quickly.

If you're looking for our type of engineering—we're looking for you. Check your Placement Office for dates when our representative will visit your school. Ask him about the McDonnell Graduate Study Plan. You may also write to:

Technical Placement Supervisor
Box 516, St. Louis 3, Missouri

VERNON E. NETHERTON
Design Engineer—Airplane Division
B.S.A.E. U. of Illinois 1947

Vernon had a fresh approach to the problem of landing high-speed jet aircraft on carrier decks and was responsible to a large degree for an improved landing hook now being used on McDonnell airplanes.

Starting his engineering career "on the board" as a Draftsman in 1947, Vernon is now a key member of a design group concerned with the F-101 Voodoo airplane.

If your interests lie in the field of airplane development, a challenging career awaits you at McDonnell. We need more young men like Vernon Netherton—*engineers with a new approach.*

BUILD YOUR FUTURE WITH A COMPANY . . . . YOUNG IN YEARS, YOUNG IN SPIRIT AND IDEAS

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Manufacturers of AIRPLANES AND HELICOPTERS • ST. LOUIS 3, MO.

HOW HERCULES HELPS...

Hercules' business today helps almost everyone's business. It embraces the production of synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products, and many other chemical processing materials—as well as explosives. Through close cooperative research with its customers, Hercules has helped improve the processing or performance of many products.

...TO STRENGTHEN PAPER TOWELS

Paper towels absorb more moisture without falling apart when Hercules Kymene® resins are added in manufacture. These resins, a few of many of Hercules' varied papermaking chemicals, help improve many other types of wet-strength papers and paperboard, including map paper, V-board, and bag papers.

...TO GREASEPROOF FLOOR TILE

Vinyl and asphalt-type floor tiles are processed with Neolyn® or Mastolyn® resins to give them "built-in" resistance to both grease and alkalies, while lowering manufacturing costs.

...TO IMPROVE AUTOMOBILE FINISHES

Lacquer made with nitrocellulose and other Hercules ingredients gives more and more cars, trucks, and buses their lustrous, longer-lasting beauty. No other finish dries so fast.

HERCULES

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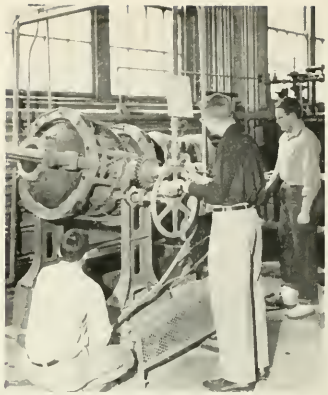
EC54-2

There's More to it *than* POTS!

by Victor J. Tennery, Cer. E. '54



One of the rotary smelters used in making experimental frit batches.

The purpose of this article is to acquaint the reader with the Department of Ceramic Engineering and its forthcoming role in the Engineering Open House. A number of people here on the campus are only vaguely acquainted with the term "ceramics," and even less familiar with the curriculum of Ceramic Engineering. It is sincerely hoped that the following will somewhat enlighten said people.

Although ceramic education at the University of Illinois owes its origin to a plan originated and formulated in 1894 by Geology Professor Charles Wisley Rolfe, a bill authorizing the Department of Ceramics was not passed until December 10, 1905. It was conceived with the ideal that "the best preparation for the management of large ceramic interests is not to be found in the factory or in the yards, but in the school with courses and equipment especially adapted to the purpose, and under instructors with broad training."

The work in ceramics was started at once, and for the academic years 1905-10, courses in ceramics and ceramic engineering were given under the direction of the Department of Geology in the College of Science. From 1910 to 1915, the courses were under the direction of a separate Department of Ceramics, also in the College of Science. Since Sept. 1915, however, the work has been administered by the Department of Ceramic Engineering in the College of Engineering. At the present time, the faculty is under the administration of Dr. A. I. Andrews, head of the department.

In 1915-16, the present Ceramic Building on Goodwin Avenue was constructed.

The department is well equipped to perform research and development in all phases of ceramic technology, such as refractories, glass, porcelain enamels, electrical porcelain, abrasives, all types of whitewares, and structural clay products.

Some of the more specialized equipment particularly necessary for this comprehensive research include:

X-ray equipment: *X*-ray units and auxiliary equipment make *X*-ray studies possible at room temperature and at temperatures up to 2900°F. This is one of the few laboratories equipped to carry out *X*-ray studies at elevated temperatures.

Sonic apparatus for the determination of the elastic moduli of ceramic materials: This unit is used to induce and measure the resonant frequencies of ceramic specimens of diversified shapes and sizes.

Quenching furnace for high-temperature phase equilibrium studies: This furnace is used to heat small specimens to temperatures as high as 4200°F. in a vacuum, or in reducing or neutral atmospheres.

Fatigue testing apparatus: The fatigue strength and fatigue life of various metals are determined by subjecting a suitably designed specimen to cycles of completely reversed stress.

High-temperature furnace for firing small specimens in various atmospheres: This type of furnace is used to fire compositions containing carbides, nitrides, or borides which would be readily oxidized at high temperatures in a normal atmosphere. It is also used to fire metal-ceramic bodies when special atmospheres are required.

Flame photometer: The flame photometer is used for the rapid determination of sodium, potassium, and other ions in solution and is particularly valuable for the determination of alkalies in ceramic materials.

Thermal analysis: This apparatus is designed such that a substance as a clay mineral can be placed in a furnace beside a neutral body (usually alumina) and heated at a uniform rate so that temperature differences can be detected. The temperatures at which these differences occur are important in identifying substances in mixtures.

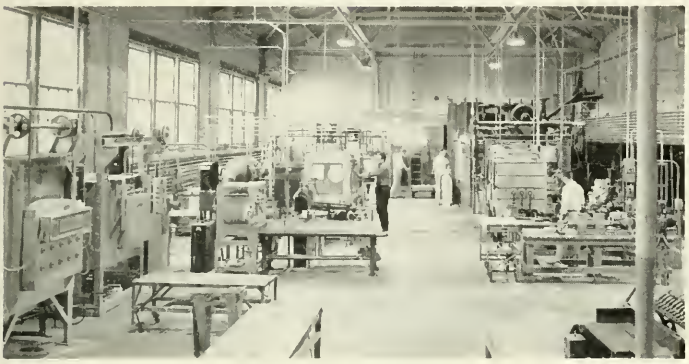
For measuring the liquid tempera-

The Ceramics Building on Goodwin Ave.

ture of a glass, a dual gradient platinum-wound resistance furnace is used. Special equipment has also been constructed to prepare and test small glass rods in tension.

A specially designed "Globar" melting furnace is used to melt experimental glass batches. This furnace is unique in that the crucible containing the glass melt is rotated constantly to promote homogenity.

Other major research facilities included microscopy equipment, which is used extensively to study composition, structure, and optical properties of materials, and thermal expansion apparatus such as interferometers and dilatometers.



Kiln House Laboratory

Only some of the department's main research equipment has been described, these being supplemented by much other laboratory equipment, and semi-plant installations.

The first work in ceramics was given under the administration of Professor C. W. Rolfe, the originator of the plan. He served as general director from 1905-10. Succeeding him in that position to the present day were Dr. Ross Coffin Purdy, Albert Victor Bleininger, Roy Thomas Stull, Ralph Kent Hursh, Dr. Edmund Wight Washburn, Cullen Warner Parmelee, and Andrew Irving Andrews, respectively.

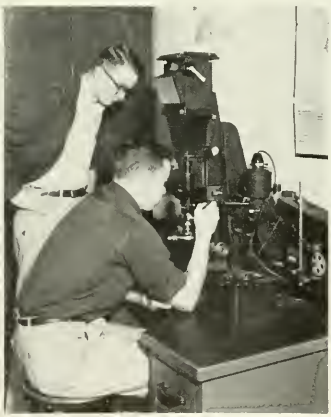
In 1913, Dr. Bleininger organized the first of a series of short courses and conferences for men in the structural clay products industry. At present, the conference is an annual two day affair of interest and value to those concerned with production and control problems in the manufacture of structural clay products.

Professor Parmelee initiated the Conference on Glass Problems in 1934, with the expressed purpose of taking up problems in the industry. It has traditionally appealed for the most part to operating and plant people.

In cooperation with the Department of Ceramic Engineering, the Porcelain Enamel Institute conducted its first Shop Practice Forum in May, 1937. Designed as a meeting for enamelers to discuss the practical aspects of industrial porcelain-enameling, the first forums were so successful that they have become an important annual meeting, held alternatively on the campuses of the University of Illinois and Ohio State University. The proceedings of the forums have proved to be an important contribution to the porcelain-enamel literature.

Research projects have been sponsored in co-operation with the Enameled Utensil Manufacturers' Council and with the Power Plant Laboratory of the Air Force.

This program was conceived in an effort to find materials with which to replace alloys containing critically short metals and to develop materials which can be used to contain temperatures in excess of those now possible in aircraft applications.



Students using the photomicrograph equipment.

Augmenting the instructional and research program of the department, are the research investigations carried on in the Engineering Experiment Station.

By this time, it is hoped that the reader has a little better concept of the aims and accomplishments of the department. Some of the equipment described besides various displays of products of the ceramic industry will be on exhibition during the Open House. Demonstrations of the operation of the equipment will be given periodically during the Open House hours. Also, souvenirs prepared by the students of the department will be distributed to the public.

Technocracks

Zoo Visitors: "Where are the monkeys?"

Keeper: "They're in the back, making love."

Visitor: "Would they come out for some peanuts?"

Keeper: "Would you?"

* * *

A very rich deposit of oil was discovered on the farmer's land. Immediately he rushed in to town to purchase a new car. An obliging salesman showed him a sleek roadster selling for $5,000.

"I am prepared to pay cash," said the farmer. "Will I get a discount?"

"Why certainly," replied the salesman. "We will give you a 10% discount on a cash purchase."

Not being confident of his ability as a mathematician, the farmer said he would think it over and return later.

He walked into a restaurant and over his coffee tried to figure what his discount would be, but to no avail. Finally, in desperation he turned to the waitress and asked, "If I gave you 10% of $5,000 how much would you take off?"

Blushing prettily, the waitress whispered, "Would my earrings bother you?"

* * *

"What are you in jail for this time, Mike?"

"Fer mindin' my own business, yer Honor."

"Come, come now; you must have been shoplifting or something."

"Well, that's my business."

* * *

A husband went out with the boys one night, and before he realized it the next day had already dawned. He hesitated to call his wife, but finally hit upon an idea.

"I'm back!" he shouted into the phone. "Don't pay the ransom!"

How Business Uses IBM's Great Electronic "701" for Data Processing

This giant computer, located in IBM's main New York office, is one of 12 already in use. It has been working at top speed from 16 to 24 hours a day ever since it was installed.

It has been solving business and scientific problems requiring as little as one minute of machine time and as much as 50 hours.

Its versatile abilities have been put to work at everything from allocating departmental costs for a bank to calculating design specifications for heavy industry.

It has helped a petroleum company blend its gasolines and figured out a multi-million dollar annual budget for a complex supply operation.

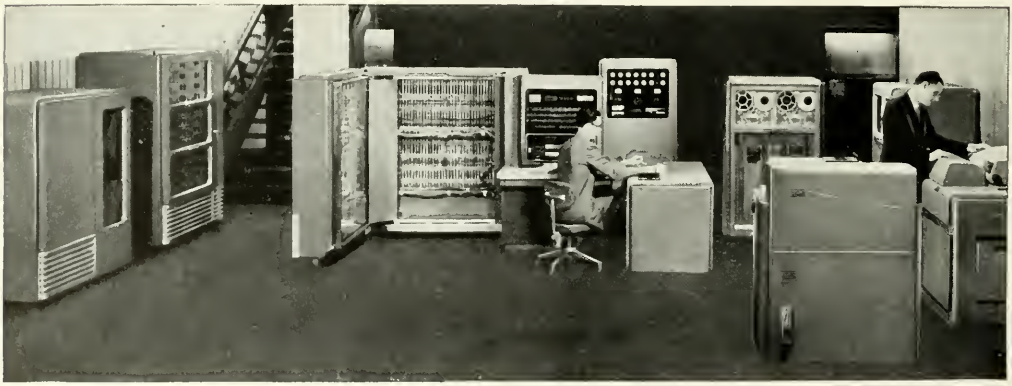
Perhaps of even greater significance and promise is the machine's successful solving, through linear programming, of highly complex business problems using the new techniques of operations research.

In the solution of the wide variety of problems suited to its great capacity, the "701" does the job with tremendous savings in time and money for its users.

How Science Uses the "701"

Here are a few of the many scientific problems the "701" has helped solve:

- Analysis of the structure of the atom
- Molecular energy levels
- Oil reservoir calculations
- Magneto-ionic refractions
- Trajectory calculations
- Reactor design
- Seismic wave calculations



These eleven connected units are known as the IBM Type 701 Electronic Data Processing Machines. The average age of the engineers, physicists, mathematicians and technicians who developed and designed these machines, which embody the latest advances in electronic computing circuitry and high speed mechanisms, was 28.

If you are interested in a technical or non-technical explanation of how the "701" operates, the IBM staff at 590 Madison Avenue, New York City, would welcome your visit. Visiting hours are from 10:00 A.M. to 4:00 P.M. daily except Saturdays, including Spring and Summer vacation periods.

IBM
TRADE MARK

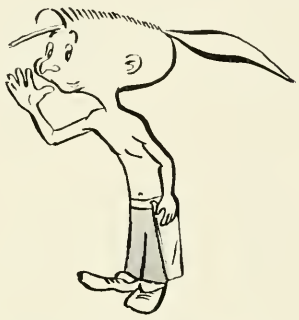
International Business Machines
590 Madison Avenue, New York 22, N. Y.

Principal engineering laboratories and manufacturing operations are at Endicott and Poughkeepsie, New York and San Jose, California.

I'm . . .

Chief TECH-I-ENGI-GRAPH

by Dave Templeton
FAA '55



I had just finished my eight o'clock class and left behind a heated debate with an instructor who had different ideas than I. Desiring to cool off, I headed for the shore of our beautiful Bone Creek which flows through the garden spot of the United States, otherwise known as Champaign-Urbana. Fighting my way through the thick wilds which border the creek (behind the Physics Lab), I heard some noise which I had never encountered before. I'd heard strange noises uttered by new freshmen ("What's so tough about Illinois? I'll knock 'em dead here") and I had come to accept the grunts, groans and maniacal screams of the seniors . . . the mutilated masses of humanity who have been around here for four years. But this sound was very different.

Snapping my way past the last bush, I came onto the banks of the Boneyard and there across the water sat a little guy who looked something like an Indian. Now I've never seen a real Indian before. There's a fella here who gets dressed up in a crazy outfit and jumps around at football games and they tell me he's Chief Illiniwek . . . symbol of the Fighting Illini. But I had to admit that this little individual looked for real.

He looked as though he was really enjoying himself. Just relaxing, sitting on some old T.A.M. and Trig. books and fishing away, as if he didn't have a care or an eight o'clock class in the world.

He looked up and I waved and smiled at him. He waved back. The kid must have been new around these parts because he lacked any fear. The last time anyone smiled and beckoned to me, I ended up being signed into Saturday classes.

Wishing to meet someone who had been untarnished by campus life, I looked around to find some way of getting across the tremendous expanse of water. My shoes and socks were too valuable. If I bent over to take them off, I'd never straighten up again . . . two and a half years on this campus does that to a guy. Suddenly, realizing I had some books in my hand, I threw them in to use them as stepping stones. After all, what are they good for except as door stops and stepping stones across the Boneyard?

Sitting down next to him, and having gotten closer now, he looked rather familiar.

"Haven't I seen you some place before?" I asked in my typical original fashion.

"Yeah. You probably saw me on the cover of the October issue of the Technograph."

"Yeah, that's where. But you don't talk like an Indian. No 'um's' on the end of your words."

"Oh, that. Look. How many stories have you read and how many programs have you heard with the Indians talking like a bunch of uneducated jerks?"

"Just about all of them," I answered, closing my mouth, hoping he hadn't noticed my tourist expression.

"Okay. You're talking to a little Indian who's been around. Sort of a B. I. O. C.; big Indian on campus. But I'm staying away from these crazy college kids. They're the most uncivilized civilized people you'll ever run into."

"Even art students?"

"Even art students." He eyed me suspiciously.

"But I'm staying around because the boys over at the Tech office want me for pictures to put in their mag. Now I'm not doing this to build up my ego. It's just that we Indians are fading from the American scene and I'm trying to give us a little publicity."

Noticing my dampened books bobbing in the water, he retrieved them before I could let them float downstream. He started a fire with a strange looking object, in order to get the books dried out.

"But to be frank with you," he continued, "the boys haven't been giving me much space since the October issue. I've been thinking of moving on to happier hunting grounds . . . publicity-wise."

"But you can't do that," I protested.

"And why can't I?" he said, straightening up to his full three feet and throwing me a glance that backed me into the Boneyard. My valuable shoes and socks were ruined.

"I heard the fellas at the Tech office say that they were going to officially use you as their mascot . . . their symbol." His feather jumped a few inches at this. "And to top that, they want you to be at their booth at the ENGINEERING OPEN HOUSE." I managed to say the last two words in caps.

"Well this puts a new slant on things," he said, checking his protractor.

"You'll stay?" I asked, putting as much of a pleading tone into my voice as I could since my benzedrine tablets were beginning to wear off.

"Sure, if the boys can use me."

"By the way, what's your name?"

"Chief Tech-i-engi-graph."

"Without the 'um' on the end?"

"Without the 'um' on the end."

My books were dry and I picked them up.

"Well, I'm glad we're going to see more of you, Chief."

"Me too, Dave."

"How'd you know my name?"

"You forgetting your name and identification number the university stamped across your forehead?"

A member of Alpha Phi Omega.

"Oh yeah," I laughed sheepishly, putting my hand to my head to cover the hole that was there.

He waved good-bye. I waded into the Boneyard and started across. I stooped and dipped my books in the water. After all, how interesting can a dry book be, anyway? I sloshed onto the south bank and headed for my nine o'clock class.

Aviation Noise

by Gene Bold
Aero '55

The physical causes of sounds are well known to scientists today. Most sounds can be classified into two groups; those that can be heard by the human ear and those that can't. Further classification of audible sounds would list those that vibrate harmoniously and those that don't. By the term, harmonious, I'm referring to sounds below the painful stage and, in the case of more than one pitch, vibrating in the same phase. These sounds are usually pleasing to hear, and music, bells, conversation, etc., are examples. The human ear can detect sounds ranging up to one hundred seventy decibels. This marvelous power leads to its own difficulty, for the range of painful sounds lies well below 170 decibels. Sounds that vibrate with intensities and volumes that cause pain to the listener are common. The siren is an excellent example of a device used as a warning because of the sound emitted. It is unfortunate, but there are many other devices that act as sirens because of the similarity of their operation. The turbine of a jet engine, the propeller of a reciprocating engine, and the turbine of a siren all have the same result. They produce sounds which because of their intensity, can be classified as noise.

These audible sounds and the ones above the perceptive range of the human ear are subjects of much research. The full scope of their power has yet to be revealed. It is known, however, that they have definite physical and psychological effects on those that must tolerate them. Definite cases of a disease known as "sonic sickness" which results in extreme fatigue, nausea, nervousness, and even temporary deafness have been attributed to supersonic sounds.

One will agree that a conventional multi-engine aircraft turning up can raise quite a racket. In this case there are two main causes of noise, the power plant and the propeller. Another bothersome noise factor is the passage of the aircraft itself through the air. Guy wires, airfoil surfaces, landing gear, and cowlings, all contribute and each vibrate with their own frequency. In the jet engine, noise is caused primarily by two actions. The reciprocating turbine and the passage of gasses through the exhaust cause sounds of extreme intensity. To attack one of these elements would be to attack the source.

In the case of the reciprocating engine a muffled exhaust system is necessary to cut down on the noise. To build an adequate muffler without sacrificing engine performance would add as much weight to the aircraft as the weight of the engine itself. Engineers agree that at the present time there is no known method of successfully muffling an engine of the size that is used on commercial and fighter aircraft. Successful mufflers have been built for use on small aircraft of the Stinson type which although bulky, have managed to eliminate a greater part of exhaust noise without destroying the efficiency of the aircraft.

In the field of propeller design, research is now underway which involves the increase in the number of blades, a decrease in the surface area of the blades, and the slowing down of the propeller revolution. Primary noise source is at the tip of the blade which revolves the fastest, but to slow down revolution requires reduction gears which again are bulky and heavy.

The jet engine presents the greatest problem. Muffling its noises at their source are almost impossible. Effective measures are being taken to protect ground crews, and personnel while the aircraft is on the ground, though. Sound insulated test houses, sound-proof working spaces, and portable mufflers many feet long have been used successfully. The British have tried building walls around the test areas which deflect the sounds skyward. No solution has been forthcoming for the successful curbing of the noise while the aircraft is airborne.

Civil authorities are painfully aware of the problems brought about by the jet airliner and its future cousin, the rocket propelled aircraft. Where before, residents of air terminal communities have become accustomed and even learned to tolerate the roar of propeller driven aircraft, the combination of jet, rocket, and propeller planes have caused extreme consternation. Authorities are now faced with the problem of revising their zoning laws which were outmoded and were only a compromise at their outset. The attitude that one has only to pass a law stating that aircraft will detour around their respective communities is foolhardy as well as unintelligent. All air terminals have "flight paths" which aircraft planning to land are supposed to follow, but these are only general in scope and do not take into account conditions such as weather, number of aircraft in the area, and the type of aircraft in the pattern.

In this article I have tried to present the problem as it exists today. I have not offered a solution simply because none exists which can alleviate the situation. It is evident that if a solution exists it does so at the source of the noise. The difficulties involved are numerous but not insurmountable. It has been humorously stated that noise is the price we must pay for progress. What was said in jest is proving to be reality and is no longer a laughing matter. It may well be a factor which will influence the development and environment of future aviation.

The partners called McIntosh, the manager, into the inner sanctum.

"Listen, McIntosh," said the first partner. "We find that last year's business was the best since we opened the place. We know how much hard work you put in for us, and as a special mark of our appreciation, we are making out a check for $1,000 for you."

The manager stammered his thanks.

"Yes," went on the other partner, "and if next year's business is as good as this, we'll sign it."

* * *

A rooster is the only type of an alarm clock that has to be turned off with an axe.

* * *

Chief, on telephone: "Doctor, my little boy just swallowed my fountain pen."

Doctor: "Heavens! I'll come at once. What are you doing in the meantime?"

Chief: "Using a pencil."

* * *

Mistress (to cook she has just fired): "Why did you throw that dollar to the dog?"

Cook: "I never forget a friend; he used to help me with the dishes."

The Rocketeering ILLINI

by Phil DeProtine, Aero. '55

Did you ever wonder who would have won the second world war if it had lasted only one more year? True that no one can really say what the final outcome might have been but here is something to take into consideration. As the war drew to a close in Europe, the German's long, extensive experimental program in the field of rocketry was just beginning to show real progress.

For years before the war, rocketry was an important field in Germany and one of the leading experts in the field was a scientist by the name of Wernher von Braun. Much of the early modern day rocket development may be attributed to him. Once Hitler's war machine gained control of Germany, von Braun was appointed director of the Peenemunde research and development center, specializing in military rocket research. Peenemunde was one of our major bombing targets during the war for obvious reasons. As a result of von Braun's efforts and German development, rockets passed from the stage of experimental devices to practical war machines.

The products of this research center were one of our main sources of worry. We could not afford to let the Germans continue to search for and find the answers to long range, high speed guided missile warfare.

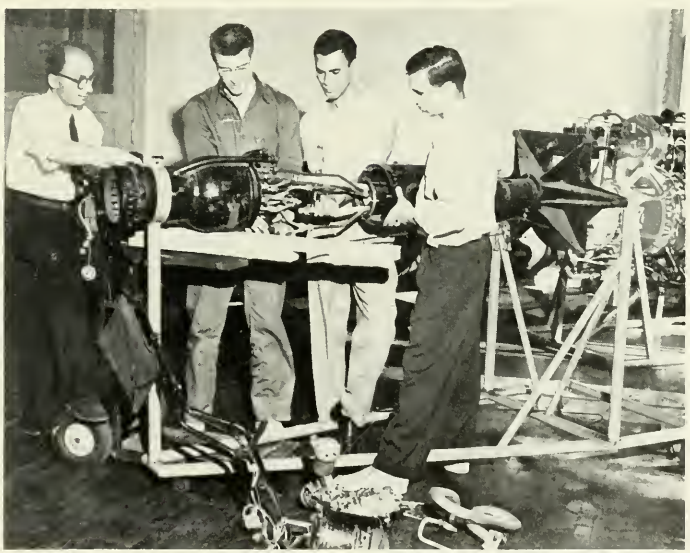
We are most familiar with the V-2 rocket (Ill. Tech. Feb.) (Victory Weapon No. 2) which the Germans had developed late in the war. The actual classification of this rocket was A-4, the rocket development program running from A-1 to A-11, the latter of which was developed in the last days prior to V-E Day. Just to point out how far along the line Geman scientists had progressed, consider the A-11 rocket. This was a long range, two stage rocket, capable of reaching New York City. The rocket consisted of a first stage, high powered unit which would detach itself when exhausted, leaving a winged, piloted V-2 rocket to make the remaining journey alone. With a gliding range of 1000 miles, this rocket might have been a deciding factor in the outcome of the war had the Germans had time to use it.

Another example of the degree of German rocket development was the air launched rocket which was controlled by wires leading from the rocket to the launching plane. Along with numerous other air-to-air, air-to-land, etc., rockets, the Germans would have had an attacking force with which we were unable to compete at that time. Fortunately, most of these weapons never were put to use against us.

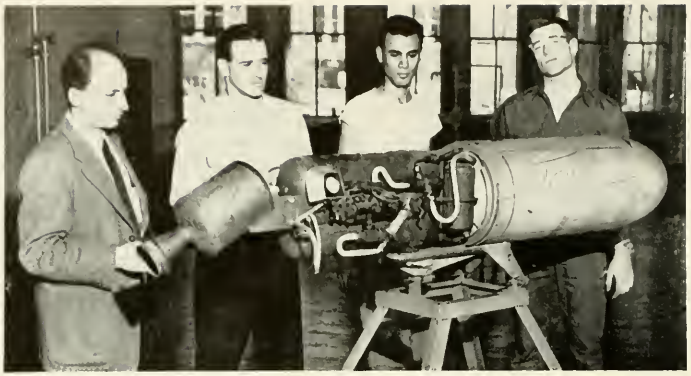
Since the war, rocket development has become a major program here in the United States. By using the Germans' experience and knowledge, we have been able to greatly improve upon the early V-2 rocket as well as developing numerous other applications for rocket power.

This development program not only stimulated interest along official lines but also in the general public as can be seen by the number of recent articles on rockets and rocketry. A great deal of interest has also been shown right here at the University of Illinois. For the first time, the Aeronautical Engineering Department is offering a course on rockets (Aero. 334) taught by Professor T. P. Torda. In view of the increasing interest in the field, the Illinois Rocket Society was recently founded, receiving strong support not only from the Aeronautic A-1 Engineering Department, but from the University as a whole, various other societies, industry and the military. The purpose of the Illinois Rocket Society is to promote experimental and analytical work in the field of rocketry and to disseminate knowledge of the theory and practice of rocketry. The society is open for membership to anyone in any college or curriculum, male or female, who has a real interest in the field of rocketry. The society stresses the fact that every member is a working one; that is, every member is expected to partake in some phase of the society's program. This is a working organization. Business and discussion meetings are held every Tuesday at 7:30 p. m. in room 115, Transportation Building. Working sessions are held intermittently on Saturdays in Aeronautical Laboratory "B".

The members of the society, coming from different colleges, have various backgrounds and for this reason it is



Assembling a rocket engine. (Photos by Jim Fisher, Illini Photographer)



Examining o liquid fuel rocket in Aero Lob. B.

essential that the program begin with the fundamental introduction to rocket theory and progress from this point on. As we work, we learn. On this premise, student reviews, discussions, and seminars have been planned so that we may learn as we prepare to exchange ideas and findings with fellow members, thus increasing our overall knowledge of the field.

At the present time, the members are undertaking several projects. The one furthest underway is the sectioning and drawing of a Walter Rocket, donated by the Aeronautical Engineering Department for use of the society. Industry and the military are also cooperating in securing more equipment for actual experimentation. The rocket is to be sectioned for study and display purposes. Drawings are made of each power plant component as it is disassembled so that the various mechanical features may be studied. Professor T. P. Torda, faculty advisor, has been instrumental in guiding the technical program which is making rapid progress. The work with the Walter Rocket enables the members to seen an actual application of the theory presented in the discussions and literature.

A second project of the society is the designing and construction of an experimental rocket test stand. This project will tend to acquaint the members with the various problems and techniques encountered in experimental testing. Along with the actual problems of construction, the problem of instrumentation, which is actually a field in itself, will be considered. It may be well to point out here that there is a need for people with varied skills, backgrounds, and interests. There is a job for everyone who is interested. It should also be pointed out that the field of rocketry deals not only with the actual power plant itself, but also with any related problems which might be encountered in the entire rocket development. This covers a rather broad area.

For those members who are unable to engage in the experimental program, the society has arranged to hold formal and informal discussion and seminar programs, enabling those members who may be interested in a specific phase of rocketry which does not lend itself to actual experimentation to investigate analytically their field. In any event, everyone will be able to actively engage in the society's activities.

The society is also making arrangements to take a trip to Purdue University to observe the experimental rocket research station located there. The trip should prove most interesting and informative as Purdue University is a leader in rocketry and has extensive facilities. During the present semester, the members plan to hold at least one meeting at the Aeronautical Propulsions Laboratory located at the University of Illinois Airport on route 45. Here the members will have a chance to observe several power plants already set up for experimentation. It is hoped that some useful pointers on testing procedure, materials, and instrumentation may be gained by

The society also plans to invite several outside speakers from the faculty and industry in an effort to broaden its source of information. Both the University and industry have been very cooperative in this respect. Although the Illinois Rocket Society is not at the present time affiliated with any national organization, it plans to become a chapter of the American Rocket Society (A. R. S.) in the near future, thus opening an even broader horizon of activity.

The Illinois Rocket Society welcomes any interested parties to attend one of its meetings for further information as to its program. Membership is open to undergraduates, graduates, staff and faculty members.

To be a successful engineer, above all you must know how to cut costs

SIMPLE DESIGN CHANGE TO STEEL CUTS COST FROM $1.15 TO 31¢

BEFORE any product design is accepted, the manufacturer asks, "Can it be built for less money?" Unless your designs pass this test they are likely to be rejected.

Knowing how to use welded steel gives you the advantage in developing any product for lowest cost manufacture. That's because steel is three times stronger than gray iron, two and one half times as rigid, and costs only a third as much per pound. Therefore, where stiffness or rigidity is a factor in a design, less than half the material is necessary.

Here, for example, is how one resourceful engineer put these qualities to work:

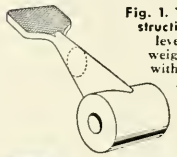


Fig. 1. Traditional Construction. Machine footlever, 10 inches long, weighs 6 pounds. Cost with broached keyway is $1.15.

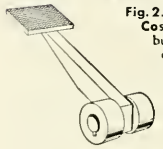


Fig. 2. Simple Steel Design Costs 41% Less. Can be built by the shop with only saw and shears. Weighs 2.7 pounds. Costs 68¢ complete with keyway.

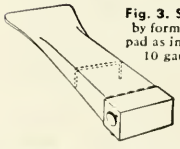


Fig. 3. Saves 53% Cost by forming lever arm and pad as integral piece from 10 gauge metal. Weighs 2.5 pounds. Costs 54¢.

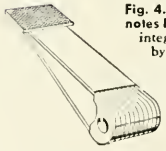


Fig. 4. Saves 73%, Eliminates Broaching. Hub with integral key is produced by stacking stampings in assembly. Arm is 10 gauge, brake formed and welded to hub. Cost is only 31¢. Weighs 2.2 pounds.

Back up your engineering training with latest information on welded steel construction. Bulletins and handbooks are available to engineering students by writing

THE LINCOLN ELECTRIC COMPANY
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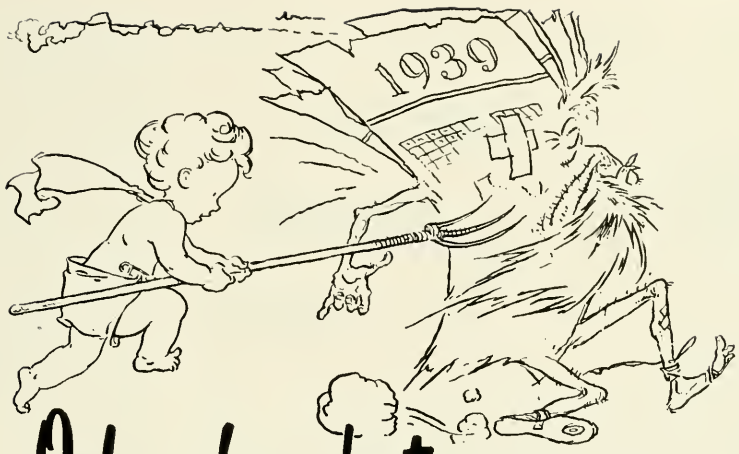
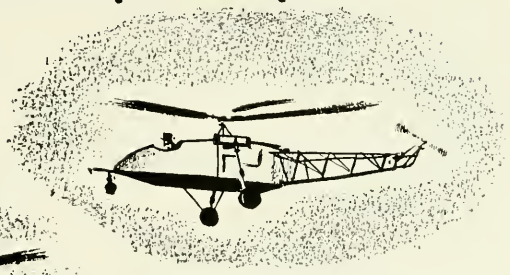
THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

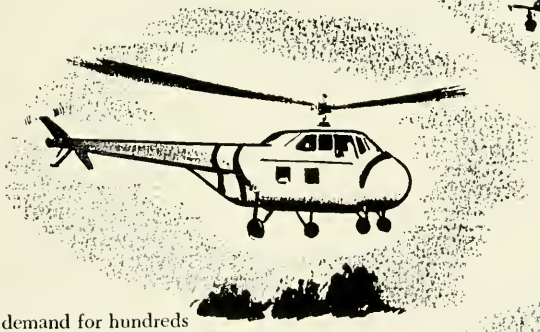


Only a few short years ago

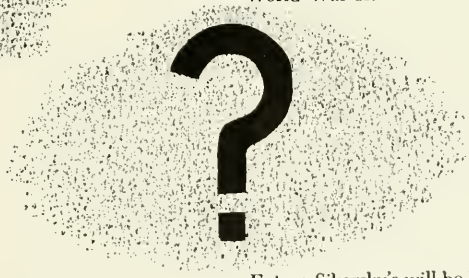
the helicopter was thought to be a "stunt" machine — amazing and amusing, and not particularly important. Events in Korea changed that idea — fast! This fledgling among aircraft performed "impossible" military assignments, spectacularly successful missions of mercy. Helicopters came into their own.



In 1939, the VS-300 with Igor Sikorsky at the controls made the first practical helicopter flight in the United States. Hundreds of later Sikorsky's were delivered for service in World War II.



Now in demand for hundreds of jobs, today's most versatile flying machine is the product of ceaseless testing, highest-calibre engineering, work and imagination.



Future Sikorsky's will be built by tomorrow's engineers. Perhaps *you* belong at Sikorsky where your skill and ability will be continually challenged.

You might find — in Sikorsky Aircraft's research departments, drafting rooms, engineering laboratories — a lifetime opportunity in this young, growing and most interesting field of aviation. Write today to R. C. Banks, Personnel Department.

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NOW HEAR THIS

Engineering Highlights

High-pitched sound waves for exceptionally fine cleaning of small industrial parts; "curved light" for pin-pointing location of flaming gases within roaring jet engines; and electronic "eyes" for measuring for the first time the width of rapidly-moving red-hot steel strips were among engineering highlights of 1952 at the General Electric Company's General Engineering Laboratory in Schnectady, N. Y.

Other advancements included a plastic hoop twice as strong as steel for certain industrial uses; a robot psychologist to facilitate mass-scale pyschological and personnel testing; and advanced methods of statistical quality control for eventually providing continuous control of automatic factories of the future.

Many other new developments cannot be disclosed because they come under the laboratory's heavy role in national defense.

Included in next year's more than $20 million of laboratory operations will be more than 400 developmental projects. Work included among the 62 separate fields of engineering in which laboratory engineers are engaged range from simple consulting jobs requiring only one engineer to immensely complex tasks involving more than 350 people. Essentially all the work which the laboratory does is a service supplementing the work of the other departments of the company.

High-pitched sound waves, first used industrially in 1951, were advanced through this year's developments to a point where they are now considered to be one of the most effective methods yet devised for industrial cleaning of small parts. The sound waves, known as ultrasonics, are directed through a liquid solvent to remove dirt, grease, and metal particles from small corners and crevices where the solvent alone would be ineffective. One application is in industrial cleaning of electric shaver heads.

"Curved light" is now being used in a new type of probing instrument of quartz and steel to pin-point location of flaming gases burning in tailcones of jet engines. Visible light waves from flames within the tailcone are transmitted by a curving four foot long quartz filament to a photo tube outside the tailcone where it is changed to an electric current, which can be read on an indicator. The instrument enables engineers to locate possible faulty combustion areas and unnecessary flame leakage in a continuing search to discover the most efficient design for aircraft combustion chambers.

An electronic width gage developed for the steel industry is now being used for the first time to measure continuously and automatically the width of red-hot steel strips moving speedily through rolling mills. Electronic "eyes" assure that the width of the strip is held to predetermined specifications. Use of the gage is expected to result in annual savings of more than $100,000 in trimming operations alone, in addition to obtaining increased tonnage of usable steel strips.

To help offset effects of the 1952 steel shortage, G-E engineers developed a plastic hoop twice as strong as steel and only one-quarter as heavy, for use in certain industrial machinery. When it was necessary to substitute aluminum armor for steel in wire and cable, the laboratory developed new methods for joining the aluminum strips.

A "robot psychologist," known as a psychological matrix rotator, was developed by G-E engineers and recently put into use to facilitate mass-scale psychological and personnel testing. The huge device, a king-sized electronic computer, will be used to detect misleading and erroneous questions and to improve psychological methods for selecting the right man for the right job.

Continuing developments in the field of statistical quality control now show promise of eventually providing continuous statistical control essential for automatic factories of the future. Statistical control has been described as applying mathematical probabilities to problems of management, engineering, manufacturing and research.

In the field of aviation, the laboratory announced the first modified jet engine for helicopters, and important developments in jet aircraft accessory turbines.

New production models of an analytical mass spectrometer will allow chemists to analyze chemical contents of liquids and gases in one-tenth the time formerly required. The device can also be used in isotope abundance studies, for research in rare gases, and for determining age of geological matter.

In the field of nucleonics were such engineering developments as remotely-controlled equipment to perform certain mechanical functions in radioactive areas; a series of radiation detection instruments for protection of personnel; and further advances in development of atom smashers.

In addition to developmental projects, some 20,000 precise electrical measuring instruments were calibrated during the year, in connection with the laboratory's position as the company's bureau of standards.

New Arc-Furnace Breaker for Both Load and Short-Circuit Operation

A new arc-furnace circuit breaker has been developed by the Westinghouse Electric Corporation. A compressed-air breaker with the arc chutes redesigned result in interupting capacity of 500,000 kva on 34.5 kv lines. The new design eliminates the need for a separate breaker to interrupt short-circuit currents. Tests show the breaker to be capable of handling the frequent routine load openings and also several primary-fault operations per year for two years with a minimum of maintenance.

Probably the roughest service any circuit breaker must face is with electric-furnaces. Because of "cave-ins" of the scrap metal during the melt-down portion of the furnace cycle, the breaker must operate frequently. In one typical installation an arc-furnace breaker was called on to interrupt load and overload currents 59,331 times in a 27-month period, or once every 21 minutes. A power-system breaker, by comparison, is required to operate usually no more than every few months and ordinarily the contacts are examined after a few such operations.

That frequent load-current interruption would seem to be enough to ask of any circuit breaker. Heretofore, in arc-furnace installations, a separate breaker has been used for interruption of short-circuit currents. Now the furnace breaker does both jobs—frequent operation on loads and overloads and infrequent operation on heavy short circuits.

.....*filled here*

It takes tons and tons of materials to fill the prescriptions that give strength and stamina to the steel you use

THE STEEL that's everywhere—in your automobile, in trains, machines, and buildings—is stronger and more enduring because it has been treated with special "vitamins and tonics."

STEEL GETS ITS VITAMINS from the industry's "drugstores"—the plants where alloying metals are made. Here, prescriptions usually call for ingredients by the ton. Their huge "mixing bowls" are white-hot electric arc furnaces, in which temperatures reach over 3,500 degrees Fahrenheit.

These alloying metals are refined and concentrated forms of both rare and common metals. Among them are chromium, boron, silicon, tungsten, columbium, and vanadium. Individually, or together, they give steel durability, toughness, hardness, rust and corrosion resistance, and other special qualities. Chromium, for example, is the secret of making steel stainless.

VARYING COMBINATIONS of these and other alloys are added to every ton of molten steel produced today. Without them we wouldn't have the hundreds of different kinds of steel that do so much for all of us in so many ways.

MORE THAN 50 ALLOYS—The people of Union Carbide pioneered in the development and production of alloying metals. They produce more than 50 different alloys for steel and other metals that go into products that serve you.

STUDENTS AND STUDENT ADVISERS: *Learn more about career opportunities with Union Carbide in* ALLOYS, CARBONS, CHEMICALS, GASES, *and* PLASTICS. *Write for booklet K-2.*

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Engineers—

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GENERAL

by Robert Nieman
G. E. '54

The communication of ideas in the engineering profession demands a very special medium. Words alone are insufficient to express the complicated spatial concepts of engineering. Therefore engineering drawings are a basic and absolutely necessary field of knowledge which must be mastered by every engineer. For it is through precise, detailed graphical illustrations that the engineer expresses himself and conveys his ideas to others.

Drawing is taught in the first year of the engineering curricula by the Department of General Engineering. The department also administers the curriculum of General Engineering but its major activity is teaching drawing.

For display in the 1954 Engineering Open House, the general engineering department has arranged demonstrations and exhibits of many of the techniques, tools and materials used in the drawing courses.

Pictorial drawings, being more readily understood than working drawings, are useful for presenting engineering ideas to laymen. The exhibit of pictorial drawings includes samples taken from regular classwork and demonstrations of techniques and devices used in the preparation of pictorial drawings. Also, visitors will have an opportunity to use the air brush and view a new type of stereoscopic, three dimensional projection.

Of special interest are the demonstrations and exhibits of aircraft drafting, aircraft lofting and drawings on plastic.

A geological map of Illinois will be on display along with samples of topographic maps, sub-surface structure maps, columnar sections and geologic cross-sections. Here, pictures of the earth's sub-structure as deduced from surface observations and other data, are prepared for scientific information as well as engineering use.

The perfect lettering found on engineering drawings is not always the product of just expert draftsmanship alone. Demonstrations of special lettering machines, lettering aids, ruling pens and other tools will be found on display.

Engineers and slide rules are almost constant companions. But the popular slide rule of today is not the only slide rule in existence. The general engineering department has fifty different slide rules on display with a giant seven foot model for demonstration purposes.

Nomographs, another kind of computation aid, will be demonstrated.

Since engineering drawings are often very complicated, visual teaching aids are essential in drawing courses. Models of all kinds, used for instructional purposes, are available for inspection.

It is the purpose of industry to create, manufacture and sell products. Naturally, drawings play an extremely vital role in all phases of the industrial scheme. How a product is developed, manufactured and sold with the use of drawings is vividly demonstrated by the general engineering department in an exhibit where both the drawings and the articles are displayed together. The development of every part is traced from the preliminary stage to final assembly and the drawings for each step are along-side.

Several methods of reproduction of drawings will be demonstrated as well as the use of black light.

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AERO

by Dwight Moberg
Aero. E. '54

Ever wanted to be behind the controls of an airplane? Wonder what the inside of a rocket motor looks like? Curious about shock waves? Don't fail to stop in at Aeronautical Engineering Labs A and B, where you'll see these and many other interesting exhibits.

At Aero Lab A, see the wind tunnel in operation, a device which makes possible the measurement of lift and drag forces on an airfoil at various speeds. In Laboratory B, a smoke tunnel presents a visual picture of the flow of air about a body by means of smoke streams. At a nearby display, you can actually see shock waves generated by a supersonic type airfoil.

The huge shock tube, centrally located in Laboratory B, permits the study of air flow and pressures about a body at supersonic speeds; the Schlieren photographic process is used to record the pressure distribution in the shock tube.

Be prepared for an ear-splitting roar as a tiny ramjet, no bigger than your first, bursts into life. See a cutaway model of the famous Walther rocket engine, which powered the deadly Luftwaffe interceptor aircraft of World War II. A multitude of powerplants will be on display—the world's largest pulse jet, a valveless pulse jet developed at this University, the first turboprop engine, a J-35 turbojet engine (used in the famed Thunderjet F-84G fighter-interceptor), an R-2850 reciprocating engine, and many others.

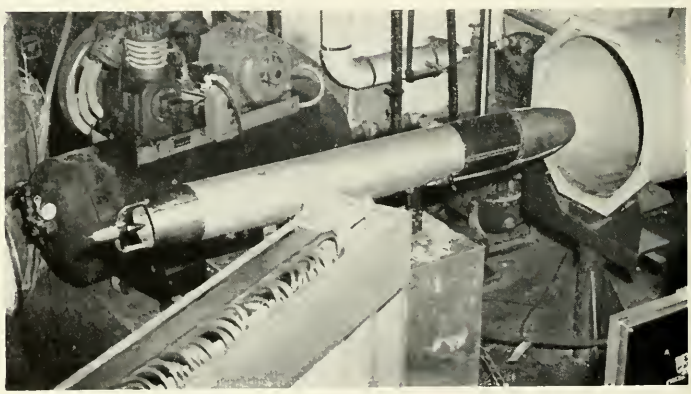
Visit the Structures Testing Lab: See polarized light used to study the stress distribution in an airfoil; watch a hydraulic drop test of full sized landing gear; and see the dynamic testing of other actual aircraft structures.

A two-place glider, built and tested by members of the U. of I. Glider Club will be displayed in Laboratory B. At the rear of this building, color films showing the latest developments in aeronautical research will be run at frequent intervals during the exhibit.

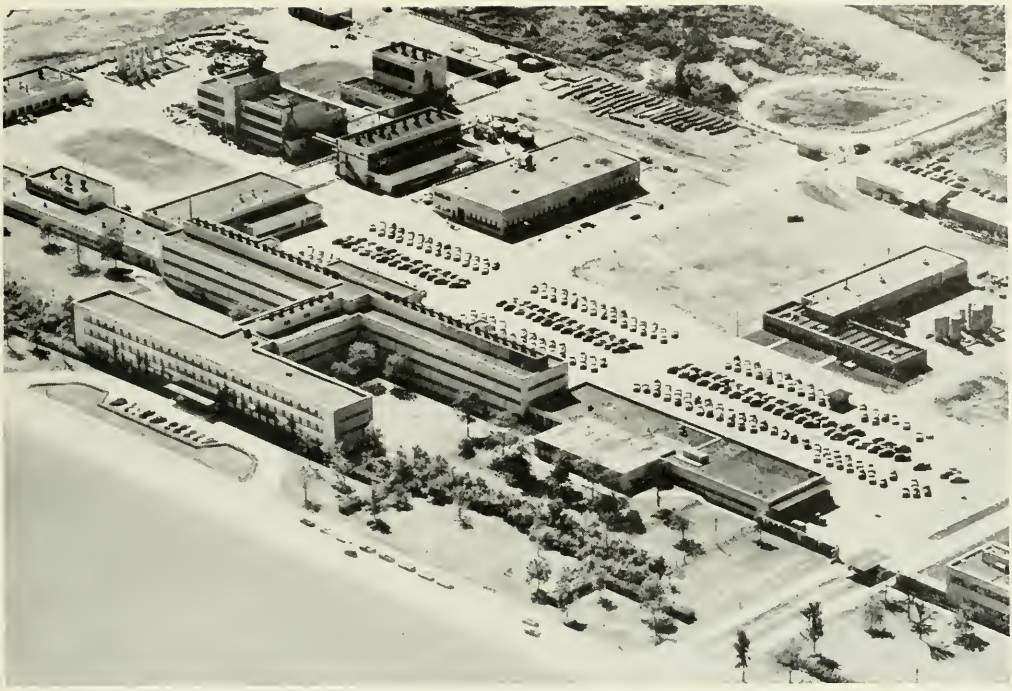
Overheard in Dean office—

Dean to engineering student: Aren't you ashamed to be seen here so often?

Student: Why? I've always thought of this as a respectable place.



A modified ram-jet prepared for a test at the Flow Laboratory. This jet was in operation at last year's Engineering Open House.



MOST OF THE RESEARCH WORK that led to the development of Ultraforming—a more efficient and economical refining process—took place in the Whiting research laboratories of Standard Oil, above. Extensive studies in seventeen research-scale units demonstrated the merits of cyclic regeneration.

Standard Oil scientists develop **Ultraforming--** the latest in catalytic reforming

After several years of research, Standard Oil scientists have developed a new and important refining process—Ultraforming.

The process is a better way of improving the low-octane straight-run gasoline found in crude oil. To make such gasoline suitable for present day cars, refiners must change it into an entirely different material, which gives good anti-knock performance. The change is known as reforming.

Ultraforming is the last word in catalytic reforming. It gives greater yields of higher octane gasoline than were previously possible and gets good results even with poor feed stocks. In addition, it raises the yield of hydrogen, an increasingly valuable by-product of catalytic reforming.

Ultraforming units do not have to be shut down when the catalyst begins to lose activity through use. By a new technique, an improved platinum catalyst is regenerated to maintain peak performance.

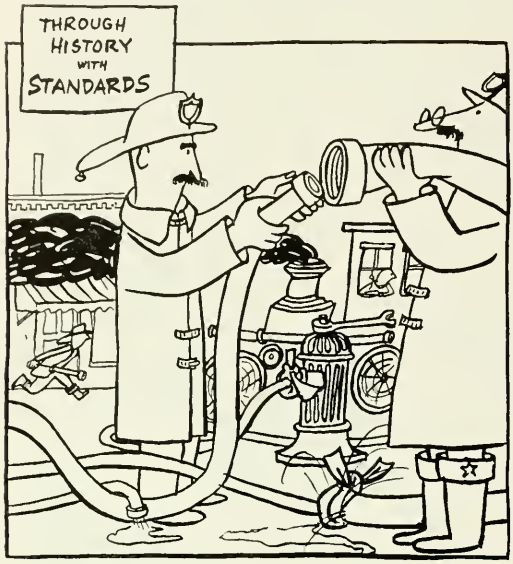
The advantages of Ultraforming over previous methods are so great that Standard Oil and its subsidiary companies are building units at four refineries. They will start operating this year. The new process, of course, is available to the petroleum industry through licensing arrangements.

At Standard Oil, young engineers and chemists work with the stimulating knowledge that they are participating in important and lasting contributions to the oil industry and to their country.

Standard Oil Company

910 South Michigan Avenue, Chicago 80, Illinois

STANDARD



While I was musing the fire burned.
—PSALMS, XXXIX, III

HOW STANDARDIZED FIRE-FIGHTING EQUIPMENT REDUCED FIRE LOSSES

Lack of interchangeable fire-fighting equipment cost citizens of Baltimore millions of dollars when their city burned in 1904. A fire broke out on Sunday, February 7, and when it got beyond control the local fire department called on Washington, New York, and Philadelphia for help. Special trains rushed apparatus from these three cities on cleared tracks. Then the equipment stood idly by while 150 acres of the old business section was destroyed. Their hose couplings would not fit the Baltimore hydrants.

Twenty-three years later, in 1927, fire-fighting equipment from 20 neighboring towns helped save Fall River, Mass., from total destruction in another great fire. The difference was in standardization. All equipment from the 20 communities worked interchangeably. The hydrant and hose connections had been standardized.

In the intervening years the early work of the National Fire Protection Association in this field had been developed into an American Standard for this fire-fighting equipment under the leadership of the National Board of Fire Underwriters, the American Water Works Association, and the American Society of Mechanical Engineers. That standard, which was reviewed and reaffirmed early in 1953, is in very wide use in the United States. The Office of Civilian Defense has recognized the importance of interchangeable fire hose couplings in case of enemy air attack and has adopted the American Standard screw thread for such emergency equipment.

HOW MASS PRODUCTION BEGAN WITH A CONTRACT FOR MUSKETS

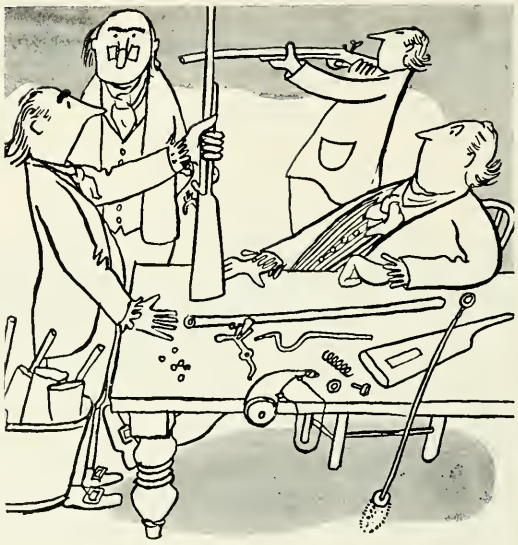
Eli Whitney has sometimes been called "the Father of Standardization," and this is why.

At the end of the 18th century, under the authorization of the Fifth Congress, Vice President Thomas Jefferson gave the inventor of the cotton gin a contract to produce 10,000 muskets. Whitney built a small factory in New Haven and started to work.

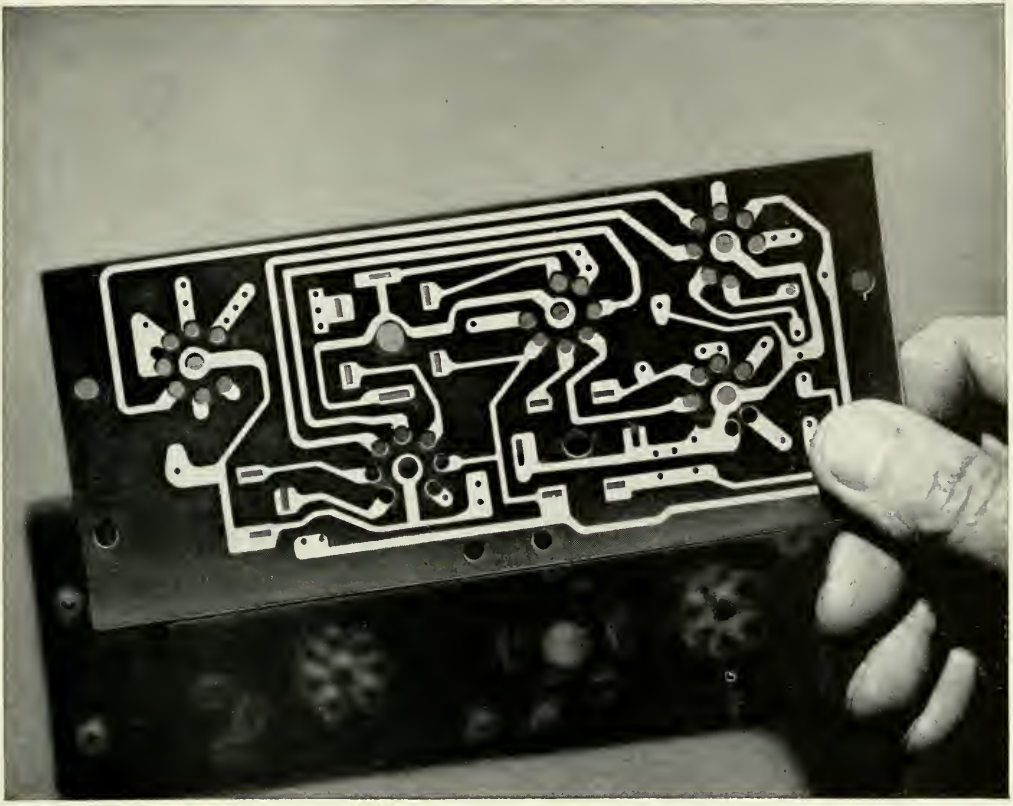
Up to that time, the traditional manufacturing method was one in which each man, highly skilled, produced by himself a particular part of the finished job. Whitney took the unprecedented step of dividing his work into steps and putting groups to work on each step in a simplified operation. Each part, copied from a model musket, was interchangeable with its standardized counterpart in the other muskets.

Whitney introduced three new aids in this work: drilling by templates (patterns), filing by jigs (guides), and milling irregular forms. He did not, however, introduce gages to inspect and control the accuracy of the product, but rather depended on keeping his tools sufficiently accurate to make the parts interchangeable.

Tooling up required many months, and Congress became impatient. At a critical stage, Whitney appeared in Washington before an assembling of government experts and Congressmen. He laid out a pile of parts and assembled ten muskets by picking standard parts at random—an unheard-of-feat. Congress was convinced, and thus mass production was started on its way in this country.

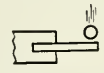


As lyke as one pease is to another.
—LYLY, *Euphues*

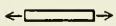


Pattern of things to come

IN ADDITION TO THE PROPERTIES ALREADY MENTIONED IN THE ADVERTISEMENT, SYNTHANE HAS



1. Impact strength. Synthane stands up in mechanical applications where jolts, jars and light shock loads are common. It does not splinter or break readily; will not delaminate.



2. Tensile strength. Synthane is strong in tension and compression.

3. Light weight. Synthane has approximately half the weight of aluminum.

4. Flexural strength. Synthane is suitable for jobs where deflexion, torsion and vibration are present. It has excellent fatigue resistance.

5. Stable Over Wide Temperature Range. Synthane is thermosetting; does not flow as temperature rises, has a low coefficient of thermal expansion.

Here is one of the brightest ideas in electronics—and one of the materials which helped make it possible. The idea is the printed circuit; the material is a laminated plastic called *Synthane*.

For years radio sets were put together by laboriously soldering a forest of wires to terminals. It was a time-consuming and expensive operation. If one connection proved faulty, the whole assembly had to be rechecked.

Then someone came up with the idea of *printing* the circuit with an acid-resisting ink on foil bonded to a base—and etching away the metal not needed. It would be quick, easy and error-proof—if the right base material could be found.

Among many tested, *Synthane* was one sheet material selected. Synthane has the necessary strength, low moisture absorption, is an excellent insulator and can be punched easily. It bonds securely to metal foil and withstands the etching acid used to remove the excess metal.

The printed circuit is still in development—but it has zoomed into favor for radio, TV, hearing aids, and many other electronic devices. There are now a dozen ways to produce what are still called "printed" circuits. And Synthane is an accepted base material for every one of them.

Synthane laminated plastics are available in a variety of grades and colors—in sheets, rods, tubes, and fabricated parts. You are invited to write for information to Synthane Corporation, 13 River Road, Oaks, Pa.

SYNTHANE CORPORATION, OAKS, PA.

SYNTHANE
LAMINATED PLASTICS

Attend

Summer School for Engineers

in Colorado's Rocky Mountains

Located in Boulder, with its mild climate and cool nights, in view of snow-capped peaks, and within easy walking distance of mountain trails and streams, the

University of Colorado

offers an unusual program of summer study and recreation . . . The

College of Engineering

provides excellent opportunities for study for undergraduate or graduate degrees, for satisfying prerequisites, for makeup, or refresher courses.

Graduate and undergraduate courses in the College of Engineering are offered in the fields of—

APPLIED MATHEMATICS
ARCHITECTURE
ARCHITECTURAL ENGINEERING
CHEMICAL ENGINEERING
CIVIL ENGINEERING
ELECTRICAL ENGINEERING
ENGINEERING PHYSICS
MECHANICAL ENGINEERING

Classroom, laboratory, library and other teaching facilities are unexcelled in the Rocky Mountain region. Regular teaching staffs are supplemented by visiting lecturers from other institutions and industry. Special research projects and seminars offer opportunity for creative work.

All courses offered by the College of Engineering run for ten weeks—

JUNE 14 to AUGUST 24

Other University courses are offered for five-week or ten-week terms. (June 14-July 20; July 22-August 24.)

The University's own Recreation Department offers a planned program which supplements education. Students have ample opportunity to see scenic Colorado. Drives over spectacular mountain highways; weekend climbs to nearby peaks with experienced guides; easy hikes to adjacent mountain spots; steak fries and picnics, and campfire entertainment near mountain streams, are all part of the program.

Typical tuition and fees for the 10-week Engineering program are $105. The charge is determined by the number of hours carried.

Living accommodations are available in attractive and spacious University residence halls, private homes, fraternity and sorority houses, and student rooming houses. Typical room and board rates are $170 for 10-week term.

Choose the University of Colorado this summer. Combine makeup, refresher or graduate courses with a Colorado vacation.

FILL OUT AND MAIL THIS COUPON TODAY FOR FURTHER INFORMATION

Director of the Summer Session, Macky 330
University of Colorado, Boulder, Colorado

Please send Engineering College information.

Your Name.....

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City, State.....

Publications . . .

FEATURE EDITOR

by Maurice Garnholtz
Aero '56

It is the job of the person holding the position of feature editor of the *Illinois Technograph* to decide, along with the other members of the editorial staff, what type of articles will be published in each month's issue of the magazine. The editorial staff decides the length of the articles and stories and as exactly as possible what the articles will consist of in their make-up.

Usually a general theme is designated for the stories that will go into a particular month's issue of the magazine. Last year, each issue featured a particular department of the College of Engineering here at the University, *e.g.*, October, 1952—civil engineering; November—aeronautical engineering; December—physics; and so on through nearly all of the divisions of engineering. In March, 1953, the annual Engineering Open House was the main topic. For one of the later issues, research in the various departments of the engineering college was delved into.

Thus far this semester, the theme for each month has been varied to a great degree. The first issue, October, was centered about the engineering freshmen for this year. The November issue featured space travel and rockets. The December copies tell of a major or interesting field of each phase of engineering as an overall theme. For January, articles have been written concerning activities around the campus and in the Champaign area.

A general or major theme is not absolutely necessary for each issue, but it does add to the coherence of the magazine and makes the job somewhat easier for the editorial staff. It is true though that a magazine filled with numerous and varied topics can be just as, or more, interesting than one with a specific theme and will often appeal to a greater number of people. As an experiment to see how it is accepted, the February issue will be a magazine approximating that idea. The articles in that and in all of the issues of the *Technograph* are usually on engineering and technical subjects written and explained so that the general public can read them with a minimum of difficulty. The subjects may also be on non-engineering topics, but will be of interest specifically to the engineer.

After deciding upon the feature articles for a certain month, the task of assigning them to the various writers on the editorial staff is encountered. This latter sentence describes almost entirely the chief work of the feature editor. As much as possible, the writers are allowed to choose their articles. These usually are about the particular fields of engineering they plan to enter after graduation. The feature editor assigns these articles at a general staff meeting or over the telephone as he calls up each writer individually, telling him what is required and desired in the article. Each author is responsible for the pictures which fit in with his specific piece of writing.

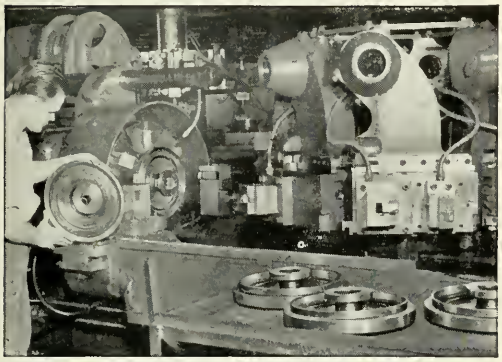
Several members of the staff are assigned permanent or semi-permanent tasks of handling monthly departments of the magazine. Some of these are the following: Boneyard Bilge—a conglomeration of incidents and seemingly unnoticed events on the engineering campus; Skimming Industrial Headlines—a summary of the new developments in industry; Engineering Societies—happenings at their meetings.

The articles are all to be typewritten, double spaced, and with one-inch margins on all sides of the written material. The first page of the story is started half-way down the sheet. The title, author's name, department and school, and year of graduation are given here. At the bottom of each page "more" is written, until the last page where "30" is typed, which designates the end.

After articles are all written and turned in to the proper basket in the *Technograph* office by the pre-assigned deadline date, the feature editor and the staff proofread them for typographical errors, grammatical and punctuation errors, and other errors and mistakes missed by the author himself.

Then the stories are sent to the Illini Publishing Company, which makes "galley proofs" of them. These galleys are long, narrow pages with all of the articles printed on them. When sent back to the *Tech* office, these galleys are proofread by members of the staff. Then the corrected articles are sent back to the publisher for the final printing. At this point, the make-up editor and his staff step in, putting the magazine together the way it is to be published.

Another page for **YOUR BEARING NOTEBOOK**

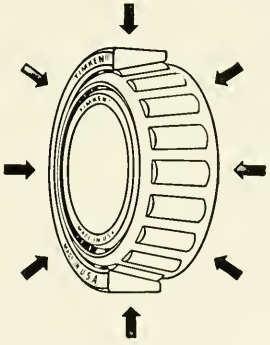


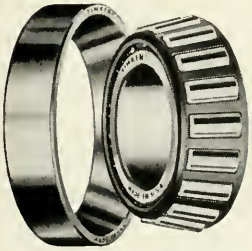
How to speed production of high precision jet engine parts

Engineers had the problem of designing a turret lathe that would machine a stainless steel jet engine part having a very complicated shape. And the part had to be produced in volume—yet with extreme precision. Naturally, they had to be sure the lathe spindle would be held rigid. To solve their problem, they mounted the spindle and gear train on Timken® tapered roller bearings, eliminating spindle vibration and chatter, insuring high precision.

Here's how TIMKEN® bearings maintain spindle rigidity

Timken bearings hold spindles in rigid alignment because line contact between rollers and races gives spindles wide, rigid support. Because the tapered design of Timken bearings lets them take radial and thrust loads in any combination, deflection is minimized, end-play and chatter eliminated. Spindles maintain their accuracy, year after year.





TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Want to learn more about bearings or job opportunities?

Many of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST —◎— LOADS OR ANY COMBINATION ✳

WHAT A NATIONAL STANDARD DID FOR ELECTRIC LAMPS

Today few articles of commerce represent so high a degree of standardization as electric lamps and their accessories. There is now complete mechanical interchangeability from coast to coast. Some 40 dimensional standards for incandescent lamps and about 30 standards for fluorescent lamps have been approved.

This standardization was worked out by the cooperative effort of the electrical manufacturers, the power companies, the fire insurance companies, and others. It is a small part of a total standardization program that probably affects and benefits more people than any other. Two national electrical standards codes encompass virtually all phases of electrical transmission and use.

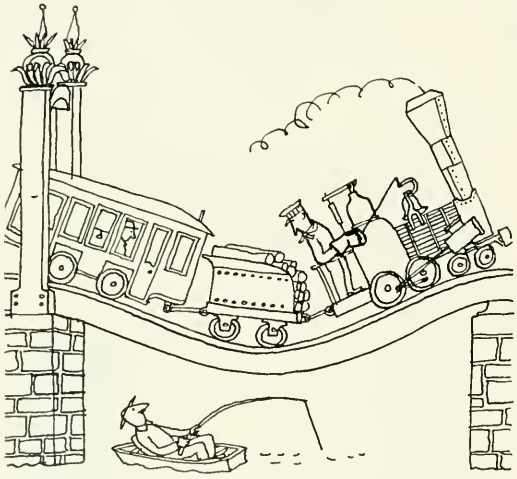
The National Electrical Code gives detailed requirements for the installation of electric wiring and equipment for lighting, heating, and power in public and private premises. It was formulated under the sponsorship of the National Fire Protection Association and was adopted as a standard by the National Board of Fire Underwriters. First published in 1897, it has been reviewed and revised many times. It became an American Standard in 1919. Hundreds of municipalities use the code in some form of legal enactment. Insurance companies use it in giving advice to their insured.

The National Electrical Safety Code provide the rules and regulations which insure the installation, maintenance, and safe operation of electric lines and equipment, including radio installations. It was formulated under the sponsorship of the National Bureau of Standards in 1913 and was approved as an American Standard in 1932. It has been adopted in whole or as a guide to practice in almost all of those states that have rules on electrical installations.

This standardization program has created a national market and has thus permitted mass production, distribution, and use of electric lamps and appliances. The result has been better convenience, greater safety, and cheaper prices. An electric lamp cost $1.75 in 1907; it costs less than 15 cents today—and lasts a lot longer.

To teach me how
To name the bigger light, and the less,
That burned by day and night.

—SHAKESPEARE, Tempest



Light burdens, long borne, grow heavy.

—HERBERT, Jacula Prudentum

HOW THE RAILROADS STANDARDIZED MEASUREMENT OF STRESSES

One of the problems that used to plague engineers was why an iron structural member would give way under a load that was clearly less than the load that tests had shown it could endure. This problem came to the fore in the first half of the nineteenth century, when it became necessary to establish standards for determining in advance the amount of service that could be expected from the wrought iron bridges that were then beginning to replace masonry bridges.

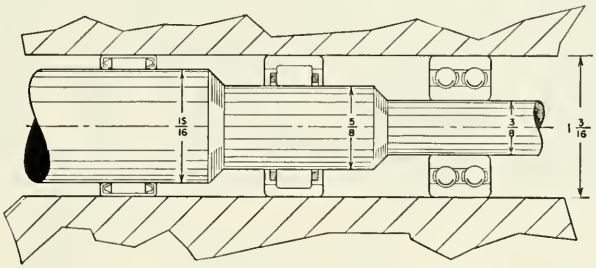
Thanks to the work of Eaton Hodgkinson and a commission appointed to study the application of iron to railway structures, it was discovered that the ultimate static load is not the only factor to be considered in determining the strength of a structure. It was learned that a load need not be the maximum load, as determined by test, to cause failure—if it were repeated often enough. It was also learned that deterioration of the material was not the determining factor in failure.

Experiments conducted by Wohler established that the range through which a stress is varied has direct correlation with speed of failure. That is, under the practical conditions of use of railway structures, for instance, load variations imposed by passing trains and the hammer effect of steam locomotives were more conducive to failure than would have been the application of a constant load.

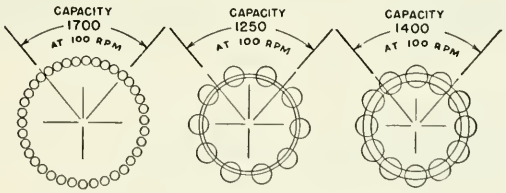
The effects just discussed are now widely recognized and are incorporated in standards issued by the Association of American Railroads and the Association of State Highway Officials.

The Torrington Needle Bearing
is designed for high radial loads

The many lineal inches of contact provided by the larger number of small diameter rollers give the Torrington Needle Bearing an unusually high load rating. In fact, a Needle Bearing has greater radial capacity in relation to its outside diameter than any other type of anti-friction bearing.



1. *Illustrates the fact that for a given housing bore size, a larger and, therefore, stiffer shaft can be used with Needle Bearings than with a roller or ball bearing.*



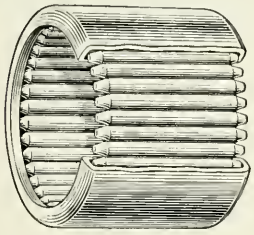
2. *Shows the greater number of lines of contact in the load zone of a Needle Bearing compared with a ball or roller bearing.*

Precision Manufacture and Unique Design

The exceptional load capacity of the Needle Bearing is the result of proper selection of steels, precision workmanship to close tolerances, and the application of modern anti-friction principles.

The one-piece shell, which serves as the outer raceway and retains the rollers, is accurately drawn from carefully selected strip steel. After forming, it is carburized and hardened. There is no further grinding or other operation that might destroy the wear-resistant raceway surfaces. The full complement of thru-hardened, precision-ground rollers is retained by the turned-in lips of the one-piece shell.

The small cross section of the Needle Bearing allows a large shaft which permits a rigid design with minimum shaft deflection, a factor of utmost importance to good bearing design.



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TORRINGTON *NEEDLE* **BEARINGS**

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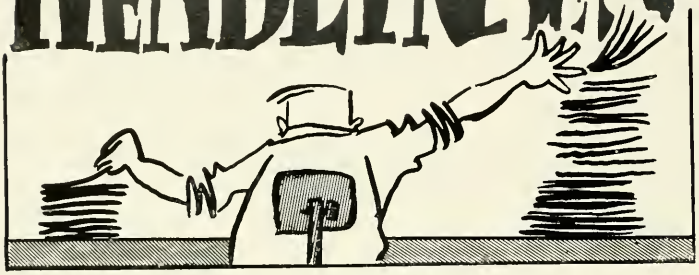
SKIMMING INDUSTRIAL HEADLINES



edited by Larry Kiefling, M.E. '56

Spherical Building to House Submarine Reactor

The saucer-shape foundation for the 225-foot steel sphere that is to house a nuclear submarine power plant being built by the Atomic Energy Commission for the U. S. Navy has been completed, and work on assembling the hull of the land-based prototype submarine is under way, the Schenectady Operations Office of the AEC and the General Electric Company recently announced.

Known as the Submarine Intermediate Reactor (SIR), this project is under the direction of the Knolls Atomic Power Laboratory operated at Schenectady for the AEC by the General Electric Company. The reactor, and the sphere enclosing it, are being built on a 4,000 acre site at West Milton, N. Y., about 18 miles north of Schenectady.

The spherical design of the reactor building was adopted to give additional protection to operating personnel and to off-site areas during test operations beyond the many safety controls of the reactor itself.

Similar structures are widely used in the chemical and petroleum industries, but the West Milton sphere will be the largest ever constructed. In the remote event that simultaneously all other controls failed, the resulting release of radioactive material would be contained in the sphere which will have a net "free" space of more than 5,400,000 cubic feet.

The outer periphery of the building will be 706 feet. The sphere will rest on the concrete saucer just completed which is 179 feet in diameter and 42 feet deep. A ring of steel columns set on concrete outside the structure and reaching to the middle of the sphere will give further support to the building. Welded steel plates will make up the skin of the ball. The plates will be hoisted into position by a derrick mounted on top of a temporary central steel tower. The derrick, now in place, reaches up 424 feet above ground level.

Every weld in the structure must be X-rayed to assure that there are no leaks. To do this on the bottom, a four-foot space is provided temporarily between the base of the sphere and the concrete saucer. After testing is completed, this space will be filled with concrete and aggregate. Inside, the concrete floor on which the reactor will rest will be slightly above ground level and the well of the saucer beneath the floor will be filled with compacted mixture of aggregate and earth. The reactor building will be air conditioned.

As soon as the columns are in place, the first ring of plates will gird the sphere at its center and assembly will proceed both upwards and downwards.

Meanwhile the hull of the submarine will be assembled just outside the building and when the latter is completed and tested, the hull will be skidded into the huge ball through a special wall section and the sphere again sealed.

The Submarine Intermediate Reactor is one of two nuclear science approaches being made to the problem of utilizing atomic fuel for underwater ship propulsion. The other is incorporated in a project at the National Reactor Testing Station in Idaho. The reactor designed for the West Milton site will use liquid sodium metal to take the heat out of the reactor core and into an exchanger or "boiler" where water will be converted to steam. The steam will then drive the turbines that propel the submarine.

Design, testing and scientific support of the SIR comes from the Knolls Atomic Power Laboratory here. The Electric Boat Division of the General Dynamics Corporation of Groton, Connecticut, is erecting the hull and power plant. The sphere shaped building for the reactor is being built by the Chicago Bridge and Iron Company.

Magnetic Chip Remover

A new GS magnet made of supermagnetic alloy offers lifetime permanence through a single pole magnetic process. It removes chips from blind drill and top holes on production lines and in assembly work. Tool and die makers will find the unit helpful in normal shop work. Assemblers and inspectors find the unit useful to test coat of surfaces for magnetic properties of the under material.

Chip remover and carrying case.

The unit can be carried in the pocket, is no larger than a fountain pen. It is mounted in a fibre nonconductive case with a pocket clip 6¼" long. Model No. 15 is ¼" diameter, price $3.75, while model No. 16 measures ⅜" diameter, price $6.50.

Vibration Pickup Calibrator

An instrument which calibrates vibration pickups and accelerometers rapidly and reliably has recently been devised by W. A. Yates and M. Davidson of the National Bureau of Standards at the request of the Navy Bureau of Ships. The device operates on the principle of the mutual inductance transducer, which was originally developed by the Bureau to measure small displacements and has since been applied in a number of NBS measurement instruments. The instrument has an accuracy of 5 percent over wide frequency and amplitude ranges, and can easily be standardized using a calibrated displacement such as that provided by a precision dial gauge.

In recent years the widespread use of vibration pickups for simultaneously monitoring a large number of points has introduced a serious calibration problem. Analysis of the problem has been complicated by the higher frequency components of vibration and resonant properties of the pickups. The increase in the number of pickups has emphasized the need for a rapid, reliable means of calibration over wide ranges of frequency and amplitude. Many of the calibration techniques now in use are limited in band width and are difficult to standardize. Others require tedious point-by-point measurement and involve a considerable problem in data reduction. The NBS instrument was designed to overcome these deficiencies.

The vibration sensing element of the NBS instrument is a stable non-contacting displacement transducer of mutual-inductance type, developed by M. L. Greenough of the NBS staff for use in other instruments. The transducer utilizes the principle that the field surrounding a coil energized with alternating current will induce current in a nearby coil. The amount of current thus induced can be controlled by placing a conducting shield at various distances from the latter coil. In the normal use of the instrument, this Bureau's calibrator, vibration of a non-magnetic conductive surface with respect to a probe containing the two coils and a carrier detector for the secondary winding generates an a-c component of output voltage proportional to the amplitude of vibration. In a-c component is measured by means of a stable vacuum-tube voltmeter, producing a reading proportional to the amplitude of vibration. It will respond to frequencies from 10 to 20,000 cps and amplitudes from 10 microinches to 0.01 inch. This is an acceleration range of 2×10^{-4}g to 4×10^{5}g.

The instrument is standardized by chopping the detected d-c voltage increment produced by a standard mechanically measured displacement change, in this case 0.02 inch, into a square wave. Fed into the same a-c peak-to-peak voltmeter on the 0.01-inch range, the square wave is equivalent to a 0.01-inch peak amplitude of vibration. The sensitivity of the voltmeter is then adjusted to obtain a full-scale reading. The choice of a displacement as an absolute standard for the instrument was made primarily because of the ease with which it can be reproduced without special equipment.

The use of a displacement transducer in this application presents both advantages and problems. The principal difficulty encountered is that of mounting the probe, since the mount itself must be free of ambient vibrations if the full capabilities of the instrument are to be realized. This requirement is met by using sturdy, rigid brackets. An advantage of this type of transducer is that it introduces practically no loading on the vibration generator. Thus, the generator can be designed solely on the basis of the loading imposed by the pickups to be calibrated, and significant savings can be achieved in equipment for high-frequency calibration.

The engineered instrument consists of the transducer in the form of a probe

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and an encased chassis which contains the electronic circuitry and to which the probe is attached by means of a cable. Direct meter indications of the peak amplitudes of sinusoidal vibrations are given. The operation of the instrument requires that the probe be mounted at a fixed distance from the mean position of the vibrating surface. For this purpose a meter indication of the probe-to-surface spacing is provided, enabling the operator to make the necessary settings quickly. This adjustment is not nearly as critical as the adjustment required by capacitive types of vibration transducers.

Pieces made with silicone-glass bonding resin

High Strength Bonding Resin

Low pressure silicone-glass laminates with initial strength and stiffness values approaching those of the organics are being made with a new bonding resin: Dow Corning 2106. Typical 1/8" samples (30% resin, heat cleaned 181 cloth) show flexural strengths in the range of 50,000 psi at room temperature even before curing.

High temperature strength is obtained after relatively short cures. Optimum strength is attained after only 80 hours at 480F, or less than half the cure formerly required. Flex strength of 10,000 psi at 500F is reached in only 6 hours, indicating that in many applications, these laminates may be cured in service. High physical strength is retained after prolonged aging at extreme temperatures.

Laminates bonded with 2106 resin are highly water repellent and resistant to many common inorganic reagents. Their bond strength, at over 1000 pounds, is comparable to that of the organics, as are their elastic moduli. Their heat resistance and dielectric properties qualify them as Class H insulating materials.

The properties of 2106-bonded laminates particularly suggest their use in structural parts which must combine light weight and high strength at elevated temperatures. While most samples to date have been laminated at 30 psi or less, indications are that laminates may also be produced with high pressure equipment.

Turbine Designers Take a Look at Super-Critical Pressure Steam

Turbine steam conditions continually edge upwards. Several machines are operating at pressures between 2000 and 2400 pounds. All the largest machines now building are for 1000 or 1050 degrees, and this year Westinghouse will have a 1100-degree machine on the line.

With fuel costs showing no disposition to stop rising, the urge to lower heat rates is as strong as ever. Engineers are casting a sharp eye up into the region of 5000 pounds and temperatures of 1200 degrees, well beyond the portion of steam tables where there is experimental proof of accuracy. Actually fundamental research on steam properties at these temperatures and pressures is needed.

At 3206 pounds absolute pressure and at 705 degrees F, water and steam have equal densities. At this condition water is converted directly into steam without boiling. There is no change in volume, no latent heat of vaporization. The same situation also exists at pressures exceeding 3206 pounds, but at temperatures somewhat greater than 705 degrees. For example, a boiler producing steam at a pressure of 3206 pounds or more needs no steam drum.

A careful study is being made of a 200,000-kw, 5000-pound turbine, with 1200 degrees initial temperature and two reheats. Early calculations indicate that by comparison with a machine of that rating but operating at 2000 pounds, and 1100 degrees, reheat to 1050 degrees, a gain in overall plant efficiency of five to six percent is anticipated.

Offhand the small gain in efficiency might not seem to justify the difficulty and cost of construction that such a high pressure and temperature entails. However, when a few numbers are looked at the complexion changes. Even a highly efficient 200-megawatt base-load plant consumes about 500,000 tons of coal per year. With fuel prices existing in some industrial areas of the United States, a company can afford to invest about a third of a million more in a 200-mw plant to gain one percent in efficiency.

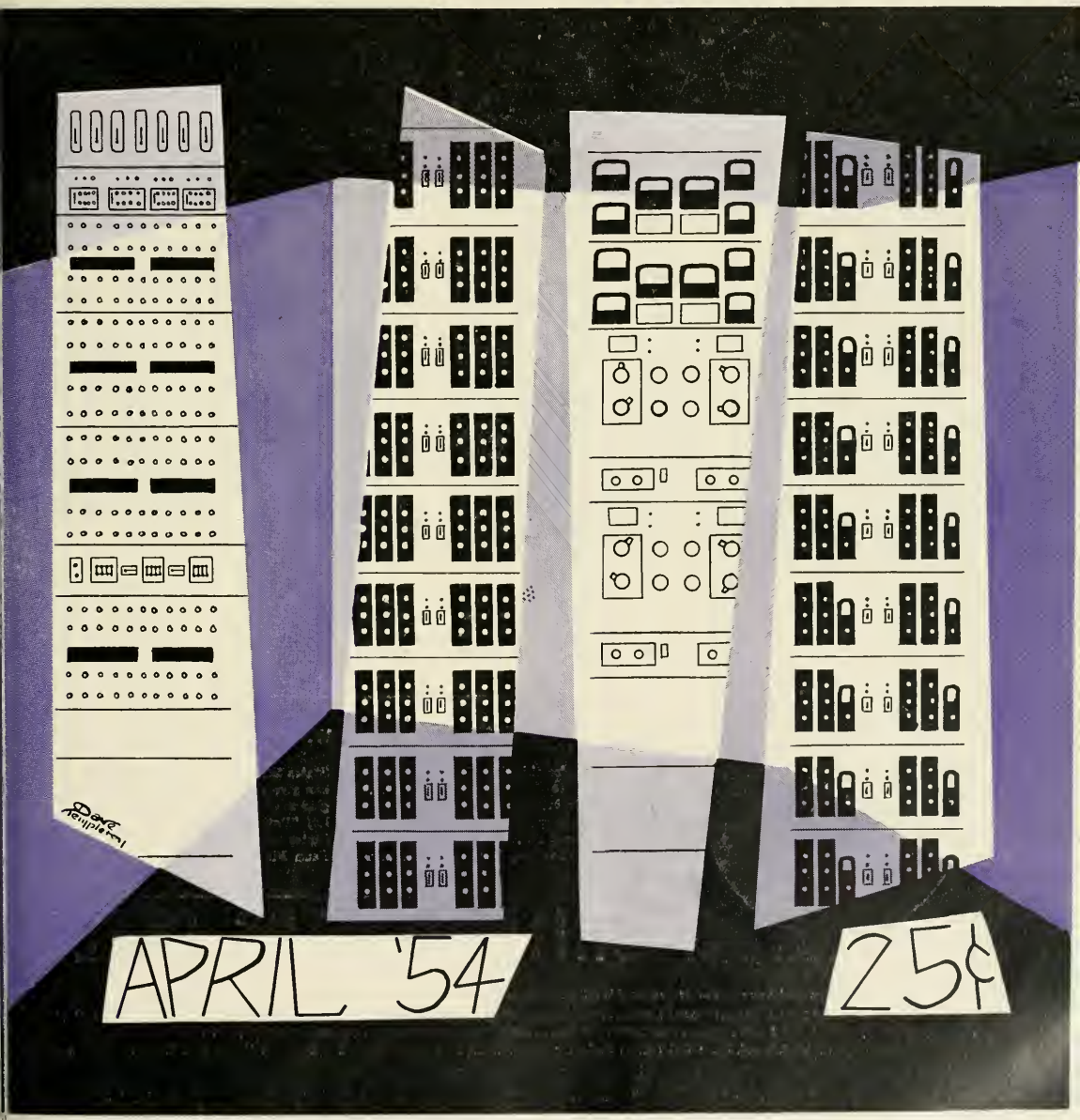
All this is in the early planning stage. It is apparent that one big problem is the power consumed by the boiler feed pump. As boiler pressures rises the energy required to inject water into it rises at a sharp rate. For example, to service a 200-mw, 5000-pound boiler by a conventional type of pump drive would require about 14,000-hp—or seven percent of the unit output. This, however, is but one of the problems involved. Conspicuous among them will be an integrated boiler-and turbine-control system. Any such plant as a whole must, of course, meet the test of operational dependability and economic justification.

Stirring Without a Rod

A new way of stirring the melt in an electric arc furnace has been developed. This melt, like soup, has to be stirred to speed up the "cooking" and provide more uniformity of the bath. But just how does one stir a "soup" of tons of liquid steel? Men have done it by hand (rabbling), and cranes sometimes tow an ingot of steel around in the melt, but both methods have obvious drawbacks.

With a d-c excited electro-magnet, Westinghouse does it by remote control. The magnet is rotated below the arc furnace. The strong flux field enters the furnace from one pole, passes through the melt, and so out to the other pole of the magnet. In so doing, it creates currents in the steel that establish a circular flow within it. The system requires about 165 kw for the rotating magnet, which is driven by a 50-hp motor.

ILLINOIS TECHNOGRAPH



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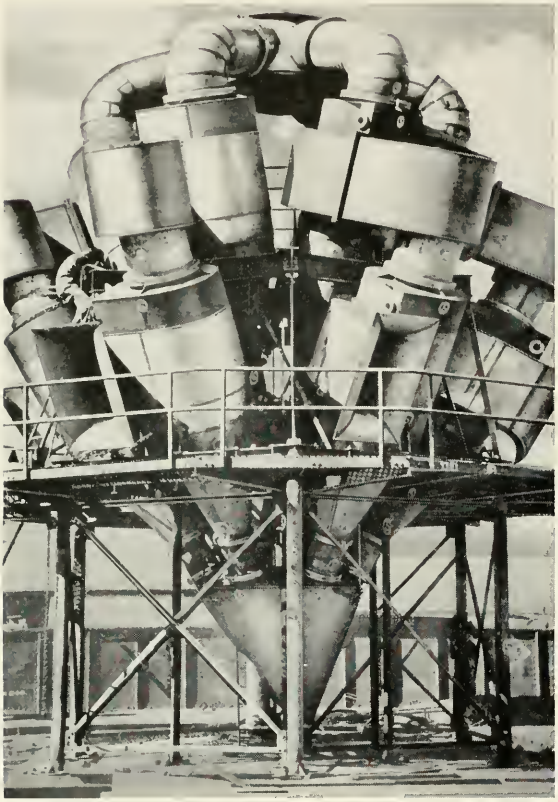
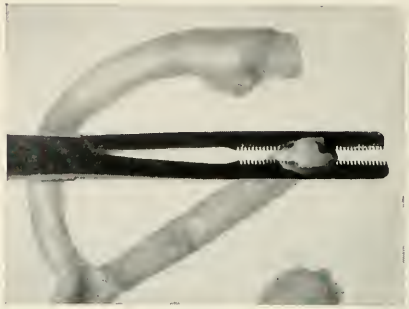


Visitor from Outer Space? No, despite its strange, other-worldly appearance, this is no product of extra-terrestrial intelligence, no flying saucer. It's a perfectly practical, very down-to-earth catalyst collector in a large petroleum refinery. Noteworthy, however, is the extensive use of USS Stainless Steel in its fabrication . . . to provide corrosion resistance combined with great strength.



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How Safe is Safe?

. . . *an editorial*

At the recent Illinois Highway Conference, Governor William G. Stratton proclaimed his dissatisfaction with the traffic accident picture in this State. He could not have exposed a more sorry landscape to the public view and one to which that same public contributes its share in apathy and indifference.

As engineers, we have an especial interest in highways and in traffic accidents. We have designed the best highways consistent with modern theory and turned them over to a public that has been used to the country lane. Something is wrong somewhere. The answer lies partly in education and partly in enforcement. It is foolish to open a new expressway through a metropolitan area, where speeds are high and congestion is at a minimum, without an extensive educational campaign advising the motorist how he is expected to act on the new facility.

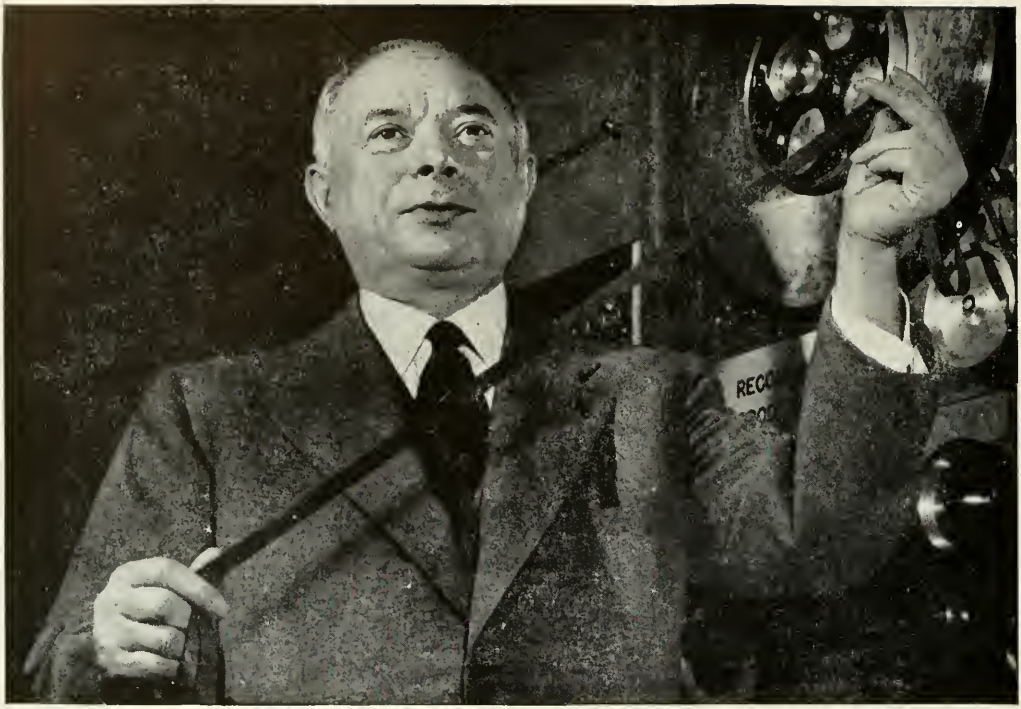
We might print up a Blue Book for Expressway Drivers. This would tell the driver how an interchange is supposed to work. What ramps go where, what lanes are for what direction. The highway is safe enough engineering-wise, but how safe is safe? It must be safe all around or it should be closed to the motoring public. Half safe isn't good enough here.

In enforcement the same ideas come into play. We haven't near enough police officers to patrol every inch of highway. The motorist must be made to understand that he is his own enforcement officer. He operates his vehicle in an intimate social relationship with every other driver and pedestrian whom he passes. If you don't believe this, try driving down the wrong side of the road sometime. This situation calls for a maximum of courtesy and a minimum of aggression. It isn't really much different from a social gathering in your own home. People can be made to feel at ease while driving their autos, too. We can operate our vehicles as if a close friend were ot our side, exercising the same caution at all times to protect his life and limb.

We feel that an extensive courtesy and educotional campaign could do much to restore confidence in the delightful privilege of operating a motor vehicle. It should be a pleasure to drive out in the country and it would be if it weren't for a few half-wits who have made our roads seem like they are inhabited with inmates from an asylum.

Courtesy means safety. Courtesy brings safety. Safety can prevent accidents. That's pretty safe.

W.H.B.



Brig. General David Sarnoff, Chairman of the Board, Radio Corporation of America

Sees No. 1 wish come true!

Television Tape Recording by RCA Opens New Era of Electronic Photography

In 1956, RCA's General Sarnoff will celebrate his 50th year in the field of radio. Looking ahead to that occasion, three years ago, he asked his family of scientists and researchers for three gifts to mark that anniversary: (1) A television tape recorder, (2) An electronic air conditioner, (3) A true amplifier of light.

Gift No. 1—the video tape recorder—has already been successfully demonstrated, two years ahead of time! Both color and black-and-white TV pictures were instantly recorded without any photographic development or processing.

You can imagine the future importance of this development to television broadcasting, to motion pictures, education, industry and national defense. And you can see its entertainment value to you, in your own home. There the tape equipment could be used for home movies, and—by connecting it to your television set—you could make personal recordings of your favorite TV programs.

Expressing his gratitude for this "gift," Gen. Sarnoff said it was only a matter of time, perhaps two years, before the finishing touches would bring this recording system to commercial reality. He described it as the first major step into an era of "electronic photography."

Such achievements as this, stemming from continuous pioneering in research and engineering, make "RCA" an emblem of quality, dependability and progress.

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Published eight times during the year (October, November, December, January, February, March, April and May) by the Illini Publishing Company. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois, under the Act of March 3, 1879. Office 213 Engineering Hall, Urbana, Illinois. Subscriptions $1.50 per year. Single copy 25 cents. Reprint rights reserved by *The Illinois Technograph.* Publisher's Representative—Littell Murray-Barnhill, 605 North Michigan Avenue, Chicago 11, Ill. 101 Park Avenue, New York 17, New York

THE ILLINOIS TECHNOGRAPH

volume 69 number 7

contents:

how sofe is safe ---- 3
evolution of the crawler ---- 7
re-refined oil ---- 13
lee de forest ---- 16
multiplying electrons ---- 20
nickolaus copernicus ---- 25
the cover ---- 26
machine with o memory ---- 30
introducing ---- 38
architecture ---- 42
engineering opportunities ---- 45
1954 engineering open house ---- 46
skimming industrial headlines ---- 53

our cover

The Network Analyzer in the Electricol Engineering Department is used to analyze all electrical circuits of ony magnitude or complexity. The cover shows the artist's conception of the various control panels and banks of resistors, inductors, and capacitors.

our frontispiece

With Chicago's famed Soldier Field forming o backdrop, o Caterpillar 10-ton tractor with an eorly bulldozer model worked on part of the construction of the Stadium in 1924.

Evolution of the Crawler

50 YEARS ON TRACKS

•

by Don Arnold
E.E. '55

•

This year marks the fiftieth anniversary of the world's first successful track type tractor. It was in 1904 that the first practical crawler was successfully tested in California. This unit is the forefather of some 340,000 crawlers which are now working in many fields.

The conception of the crawler came out of the need of a unit with compact power that would not be bogged down by the soft soil of the delta lands of California. As a result of the immense farms, some as large as 100,000 acres, combines became larger and larger. Benjamin Holt of the Holt Manufacturing Company in 1893 made a behemoth with a 50 foot cut. This machine was pulled by 40 horses and was operated by 6 men. In these delta areas, horses sank deeply in the soft soil and the need for more compact power was apparent.

In the first years of the Twentieth Century, Holt attacked the problem from the angle of a track-laying tractor. This idea of a machine that laid and picked up its own base was hundreds of years old, but the principle had never been successfully applied to a commercial vehicle. The result was the world's first practical track-type tractor—tested Thanksgiving Day, Nov. 24, 1904.

Only eight of these steamers were built. In 1906, the gasoline motor replaced the steamer, and the tractor came into demand for loggers and builders, road construction, and hauling freight.

Immediate demand for the evolutionary machine called for expansion and the purchase of a new plant in Peoria in 1909. By the middle of 1910, there were 65 employees at the Peoria plants.

During World War I, almost 10,000 of Holt's Caterpillar tractors were licensed for wartime use. Further, his crawler was the inspiration to General Ernest D. Swinton, inventor of the tank.

After the war, the government distributed most of the tractors to the various state highway departments. This year, 1919, marked an all time peak of 26 million farm work animals and truly the beginning of the end for "Old Dobbin."

In 1925 the Holt and Best Caterpillars combined to form Caterpillar Tractor Company centered in Peoria, Illinois. The years following the merger saw rapid development and an increase in new working tools for the tractor—namely rubber tired wagons and scrapers, bulldozers, rippers, pipe layers, front-end shovels, and a variety of agricultural machinery.

Meanwhile, in the late 1920s, company engineers were thinking in terms of a new power diesel. Over a million dollars was spent in research which preceded the first Caterpillar diesel tractor in 1931.

Even in the throes of the depression, reception was overwhelming. In April, 1932, one of the new tractors went to work on an Oregon ranch. Forty-six days later, the tractor finished its continuous run. It had traveled 3,500 miles and plowed 6800 acres (150 acres daily) —at an average fuel consumption of only 5.73 cents per acre! This machine dubbed "Old Tusko" by its present owners, is still operating on a ranch nearly twenty years later.

News of the unprecedented diesel economy—the fact that these new engines burned low cost fuel and less of it, cutting 50 to 80% from present fuel costs —spread like wildfire. Because of the great demand, the company soon entered the diesel engine field.

In 1933, the company sold more diesels than tractors although there were more models of gasoline tractors. By 1936, Caterpillar employment had soared to 10,000—3,000 above the pre-depression peak, and the total U. S. diesel production rose from 100,000HP in 1932 to 2,000,000HP in 1937.

Now approximately 2,200,000 square

The first practical track-type tractor is shown above as it was being tested near Stockton, Cal. It was originated by Benjamin Holt in 1904.

feet have been added to the main plant in Peoria. The new diesel engine division, covering half of this area, is considered the most modern in the world. In 1951, plans were announced to build an additional half-million square feet onto the Joliet plant and to build a 370,000 square feet plant in York, Pa. Again, on June 2, 1953, the company announced a new $45 million expansion program including a new 700,000 square feet plant at Decatur.

Today, Caterpillar produces 12 diesel power units and marine engines in sizes up to 500HP and 12 electric sets with outputs up to 315KW. In all, there are 93 different Caterpillar products produced by some 26,000 employees, 21,000 of which are located at Peoria.

To honor the crawler on its 50th birthday, Caterpillar is conducting a commemorative program with the theme, "50 Years on Tracks." W. K. Cox, sales promotion manager at Caterpillar, points out, "We believe this is a significant milepost because the crawler has played such an important role in the progress of our nation both peace and war. During this half century, it has been instrumental in the development of modern methods of constructoin, logging, mining, and oil and agriculture fields."

Today in its fiftieth year, on civil or military projects, the crawler is busier and better than before. And it can look back on an outstanding record of accomplishment in the progress of the last 50 years.

History of Caterpillar

edited by Don F. Kesler, E.E. '56

It was in 1859—when the Gold Rush was still headlines and oil newly discovered in Pennsylvania—that young Best, 21, punched a four-head oxen team across the Great Plains. Bad luck hounded him for the following 10 years as he tried gold mining, hunting and sawmilling in the Great Northwest, and failed at each in turn.

In 1869, he took charge of his brother's ranch near Marysville, California. At the time, grain was hauled from the Best fields to Marysville for cleaning, the charge being three dollars per ton. Best wondered, "Why not bring the cleaner to the grain instead?"

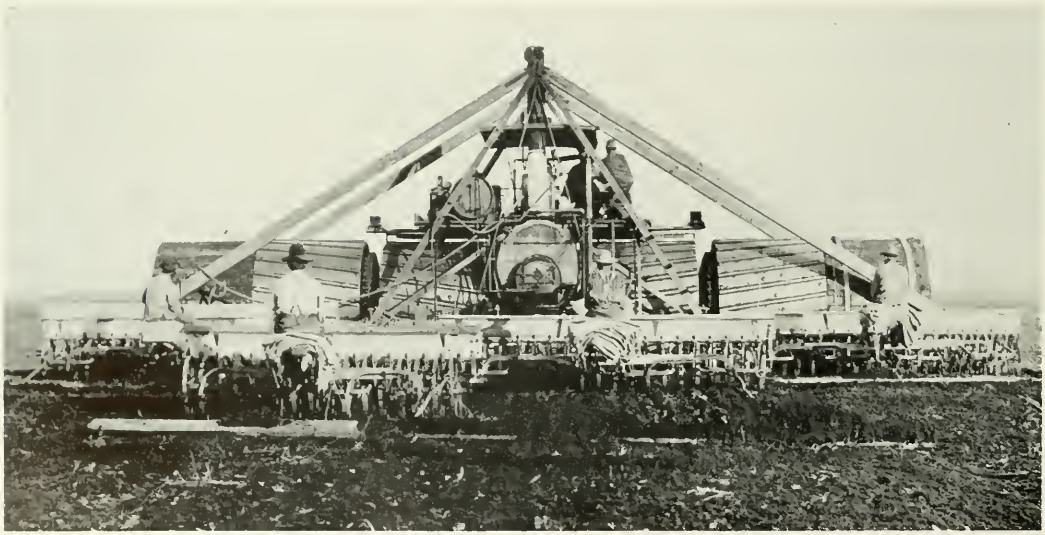
During the winter of 1869-1870, he built three cleaners which proved instantly successful. Such was the demand for these machines that Best opened a factory for their manufacture in Marysville.

For some years, several larger California growers had been attaching headers and threshers to Best equipment in an attempt to field-process wheat from standing grain to sack. Best had dreamed of building his own combined harvester in the early seventies; it was no surprise to his friends when he began experimenting in 1884 and produced and sold his first machine in 1885.

In the meantime, the Holt brothers were making similar progress in San Francisco and Stockton, California. Charles Holt left Concord, New Hampshire, in 1863, sailing for Panama on a tramp steamer. The young pioneer, age 20, plodded across the Isthmus and headed for San Francisco. Here, he first worked at odd jobs . . . later teaching school in Hydesville, California, by day, and keeping books in the local general store by night.

In 1869, having saved $700, Holt returned to San Francisco and established C. H. Holt & Company, "Importers of hardwood lumber." He was soon joined by brothers, William and A. Frank Holt. In 1873, the fast growing firm founded an East Coast factory in Concord, the family home, for manufacture of wheels, bodies and other wagon parts. Benjamin Holt, only 24 and already the ablest engineer and mechanic of the family, helped run the business.

During the following decade, it became apparent that wood products of the East did not receive proper seasoning for the hot, dry western climate. Wheels shrank, warped and fell apart under the merciless heat and sand. Charles Holt decided to manufacture wheels and other articles for wagon assembly on the West Coast in a location where hardwoods could season



To combat the problem of soft soil this special steam powered unit was built by the Holt Manufacturing Company

properly. The Stockton Wheel Company was the result, established in that city in 1883. Benjamin Holt came west to superintend the new works.

The Concord factory was disposed of three years later. By this time, Charles and Ben were the only brothers in the business, Charles managing the old San Francisco firm, now called "Holt Bros. Company."

Products of the Stockton plant were monuments to Ben Holt's inventive versatility. The 1880s saw wagons, carts, wheels, farm implements, blacksmith and building supplies not to mention railroad cars and street cars, both horse-drawn and electric! In 1886, the first "Holt Bros. Link & V-Belt Combined Harvester" appeared on the agricultural scene.

Combines of that day were ground driven; that is, internal machinery was geared or belted to one of the ground contact wheels. To get around uneven operation as horses speeded or slowed, Best patented an ingenious blast fan governor which maintained constant blast pressure against cleaner elements irrespective of the variable speed of horse travel. In 1889, he sold his first steam powered combined harvester.

Ben Holt perfected the sidehill harvester in 1891. Now for the first time, the combine could go almost anywhere a horse could go—and still operate efficiently. This development made profitable grain farming a reality on hundreds of thousands of sloping, untilled acres across the Pacific Northwest. One of the sidehill machines was shipped to Australia in 1894.

The later years of the nineteenth century witnessed great interest in land reclamation in the Sacramento and San Joaquin River Valleys. Some of the farms in the area covered as much as 100,000 acres. Here also was delta farmland stretching mile after mile without a tree or rock—a promise of wealth to any who could plant or harvest. (Old timers spin yarns of ranches so huge you could start plowing and then harvest on the return trip.) Horses was not the answer to the need for more usable power in the soft deltas.

Was steam the answer? Best and Holt led the West Coast in production of steam traction engines during the "Big Steam Era," 1890-1910. Best sold his first steamer in February, 1889. Holt followed with "Old Betsy" in 1890, an engine that incorporated his famous steering clutches (patented the following year), and which operated summer and winter for the subsequent quarter-century. With the steam traction engines, daily harvest totals occasionally ran as high as 125 acres and 4,000 bushels.

But, as capacity increased weight climbed accordingly, many steamers eclipsing the 20-ton mark. And as weight increased, wheels mired even deeper into the soft delta soil. To combat this tendency and provide increased bearing area, both companies added larger and larger wheels. Holt Manufacturing Company built a behemoth with three six-foot-wide wheels on either side, each being 7'6" in diameter. Overall tractor width was 45'8"!

In the first years of the Twentieth Century, Benjamin Holt began to approach the traction problem from a different angle. The need for a prime mover of larger ground contact area, yet with high maneuverability, led him to the idea of a track-laying tractor.

Holt ingeniously combined known ideas and created new ones, mounting a pair of rough tracks on a steam engine from which wheels had been removed. The crawler, a 40HP machine, would pull four gangs of plows two inches deeper than the Holt 60HP wheel model could pull three gangs!

In 1906, steam power was replaced by gasoline, and the new crawler became more versatile and cheaper to operate. Though its first market was the farm, it eventually became a time-saving tool for loggers and builders. In those days when motor trucking and road construction were still in their infancy, the crawler was much in demand for overland freighting as well. Later, as it helped construct the roads that made short haul freighting the exclusive province of the truck, it literally built itself out of a market.

Immediate demand for the revolutionary machine called for expansion of Stockton facilities and, in 1909, purchase of a new plant in Peoria, Illinois.

Business began to climb the following year, primarily because of foreign orders. Casteran Hermanos, Holt's Argentine dealer, succeeded so well in popularizing the track-type tractor that a standing order of 15 crawlers per month was placed with the Peoria factory. Dr. Leo Steiner of Hungary became Holt's first European dealer in 1912 and immediately placed orders for 40 machines.

The year 1908 marked the sale of Best facilities to Holt and the end of intense Best-Holt rivalry. Not for long, however, 1910, C. L. Best, son of Daniel, organized the C. L. Best Gas Traction Co., at Elmhurst, California, for the manufacture of wheel-type tractors. After three years, he marketed his first crawler, the Best "75," and competition between Best and Holt interests became keener than ever before.

In 1919, th Best "Sixty" was brought out, introducing anti-friction roller bearings in transmission and track roller frame.

In the ensuing five years, both Holt and Best sales organizations were widely expanded, products becoming well known all over the U. S. and in many foreign countries. The track-type tractor

Thousands of crawlers were used during World War I to haul personnel, artillery and supplies across the battlefields of two continents. Here o Caterpillar "75" pulls a huge howitzer across battle terrain.

led the giant road building boom of this period.

In 1925, the Holt and Best organizations combined to form Caterpillar Tractor Co., and, because of geographical advantages, manufacturing was centered at Peoria, Illinois. C. L. Best was named chairman of the board; the merger was engineered by H. H. Fair, West Coast financier and present board chairman. Caterpillar executive offices were moved from San Leandro to Peoria in 1930.

The years immediately following the merger saw rapid development, not only in the crawler tractor itself, but also in the equipment designed to work with it. New tools appeared in front, in back and on top of the crawler—rubber-tired wagons and scrapers, bulldozers, rippers, pipe layers, front-end shovels and a great variety of agricultural machinery.

After the merger, Caterpillar devoted more and more engineering and manufacturing to the needs of the construction man and road builder. To round out product line and further strengthen its background of road building experience, Caterpillar Tractor Co., acquired the Russell Grader Manufacturing Company of Minneapolis in 1928. Russell, organized in 1903, had helped pioneer the development of elevating graders, blade graders, self-propelled motor patrols, scrapers and portable crushers.

At first, Caterpillar continued the Russell Motor Patrol, a machine designed for mounting on a crawler tractor base. In 1931, production of this model was stopped. In its place, Caterpillar offered the auto patrol, integrating important features of previous graders, but introducing a product completely redesigned. Placing the engine behind the operator was one of many innovations. The machine took on a new look with engine up out of the dirt, more weight over driving wheels, mechanical power controls and rigid axle drive.

The auto patrol created new markets and methods for construction men and caused demand for a heavier, more powerful machine capable of full-fledged construction work. The versatile Caterpillar Motor Grader, first marketed in 1938, was the answer.

News of unprecedented diesel economy—the fact that these new engines burned low-cost fuel and less of it, cutting 50 to 80% from fuel bills—spread like wildfire. Because of the great demand, the company soon entered the diesel engine field, supplying diesel powered tractors and road machinery to the agricultural, construction, logging, industrial and governmental markets; and diesel engines to sawmills, cotton gins, rock crushers, irrigation pumps, industrial plants and manufacturers of power driven equipment such as excavators, compressors, drill rigs and locomotives. Later, special marine diesels and diesel electric sets were added to the fast-growing line.

All over the world, the new diesel crawler marshaled a successful struggle to send forth earthmoving costs plummeting . . . on such well known undertakings as the Prince Albert Canal, Zuider Zee, Grand Coulee and Fort Peck dams, Pennsylvania Turnpike and "Big Inch" Pipeline.

Holt got away from the bulky steam engine in 1906 when he built the first gasoline powered crawler.

The beginning of World War II brought a new need for tractors and road machinery to build airports, military roads and war plants; to clear land and haul supplies; to hit the beach with the first waves of amphibious landings . . . a need for engines and electric sets to furnish light and power for advance bases, isolated locations and bombed-out areas.

In addition, the company was asked to produce tank transmissions, howitzer carriages, shells and other war materials. A subsidiary, the Caterpillar Military Engine Company, was formed to operate a plant in Decatur, Illinois, for manufacture or radial diesel tank engines. However, wartime need for standard Caterpillar products was so acute that both Decatur and Peoria abandoned special production and concentrated on the pre-war line.

As in World War I, the Caterpillar track-type tractor became a familiar sight on World War II Allied fighting fronts all over the world. Military construction men found it an indispensable tool, particularly for the rapid-schedule airfield and road construction needs of Pacific island warfare.

After the war a huge expansion program was immediately launched to handle increased demand and build post-war additions to the company line—bulldozers, scrapers, rippers, wagons and power controls. A giant new plant in Joliet, Illinois, now manufactures this equipment.

On December 19, 1951, Mr. Neumiller announced acquisition of the Trackson Company of Milwaukee. The well-known Wisconsin firm is operated as a wholly-owned subsidiary and continues to manufacture front-end shovels and side-boom pipe layers as auxiliary equipment for Caterpillar Diesel Tractors. Trackson's two plants occupy about 150,000 square feet of manufacturing and office space and employ approximately 600 people.

In total, capacity to manufacture machines and parts has been more than doubled since January 1, 1946—at a cost of over $150 million. Dollar sales volume for 1953 ($433.8 million) was almost 3½ times that of 1946.

The entire Caterpillar parts operation is geared to quick delivery of quality parts. Under the company's unusual "No Orphans" policy, parts are regularly supplied for machines still operating in the field after more than 30 years' service.

On June 2, 1953, the company announced a $45 million expansion program, including extensive retooling and rearrangement at present plants and a new 700,000 square foot plant. The site at Decatur, Illinois, was selected the following month. The latter will be devoted to the manufacture of motor graders and industrial wheel tractors. Construction will begin early in 1954 and the plant is expected to be operating late the following year.

In 1954, its fiftieth year of significant accomplishment, the track-type tractor is busier and better than ever before. The world's number one earthmover, it is a dynamic symbol of industrial progress.

With the crawler tractor as central tool, price of the common excavation yard on U. S. highways has dropped 25% since 1900—in the face of greatly increased personnel and product costs. Because of the crawler, logs are coming out of the woods quicker and cheaper . . . crops are growing on hills and marginal lands where none grew before . . . pipelines are linking oil and gas fields to cities in an ever expanding web.

Now we find track-type tractors working on civilian and military roads . . . clearing streets and saving lives when winter comes calling . . . building dams, airports, and levees . . . tilling and terracing our farmland . . . working in deserts and forests and icelands . . . erecting bridges and buildings . . . powering crushers, cotton gins, shrimp boats and public utilities. Wherever there is construction progress or pioneering there will be found a crawler tractor.

There Is No Waste Here!

RE-REFINED OIL

by Paul W. Erb, Chem. E. '54

Reprinted from Northwestern Engineer

Change your oil? Change your oil? CHANGE YOUR OIL? Every one or two thousand miles you change the oil in your car. Under adverse conditions you may change it more often. Or perhaps you conveniently forget and don't change it quite so often. In any case there are thousands upon thousands of quarts of oil—dirty, grimy, diluted, weakened oil—removed from cars, trucks, buses, trains, airplanes, and machinery, every day of the week. What happens to all this oil? Surely it must have some value.

Much of this oil may be discarded—wasted—but sometimes it is salvaged in some manner. It may be reclaimed. That is, impurities such as solid carbon, gasoline, road dust, and water are removed by filtration and low heat treatment. But more and more, the oil is being re-refined. In re-refining all impurities, including oxidation products, dissolved in the oil, are removed by a refining process similar in many respects to that given virgin oil.

A used oil properly treated is as good as or better than new oil. According to W. S. Boynton of the Wright Aeronautical Corporation, "Re-refined oil may be used over and over again and is usually preferred to new oil. It has more body, the volume consumed is not so great as with new oil, and it has better lasting and holding qualities." Re-refining of used oil is based on the fact that oil does not wear out or break down to any great extent. Dr. Winslow Herschel, associate physicist, Bureau of Standards, states, "Oils do not wear out mechanically; they do not wear out in the sense of wear in a rope, in which the length of fiber has been shortened and which cannot again be made as useful as when new." When used in an engine, oil becomes adulterated with suspended solid impurities and dissolved liquid impurities. The removal of these impurities by correct re-refining methods renders the oil fit for use again.

Re-refining of oil is becoming big business. As early as World War I it was tested and proved, and now re-refining of crankcase drainings is a practice accepted by thousands of commercial oil users. In a recent year almost eighty million gallons of high grade lube oil were re-refined and put back into use. Most of the oil re-refining is done as "custom jobs" for industries, airlines, railroads, trucking concerns, bus and cab companies, public utility companies, and the like. The oil is collected, treated separately, and returned to the company. About seventy-five percent of the re-refiners' business is done with commercial users. Collecting used oil for re-refining and sale at filling stations is a highly localized, difficult, and rather high cost method of operation.

It has proved profitable for certain major oil users to do their own re-refining. Some of the major airlines like American Airlines and Pan American Airways operate their own re-refineries. Others, like Eastern Airlines, send their oil to a commercial re-refiner, since commercial refiners are able to restore oil to any required specifications. A major customer of the commercial oil re-refiners is the United States Air Force, which in a recent year sent out 2,700,000 gallons of used oil for reprocessing. This operation reportedly saved the taxpayers $600,000, and today the Air Force gets top grade oil for approximately 20 cents a gallon. During the recent war, re-refining returning 1,000,000 gallons of crankcase drainage a month to top grade aircraft engine oil specifications.

Re-refined, or "further refined" oil, as it may more properly be called, is actually "triple-refined." It is originally refined from the crude; it is further "refined" in the crankcase of the car, where the remaining sulfur is oxidized and the weaker hydrocarbon molecules are broken down; and it receives its third refining in the re-refining process, where these impurities are removed along with other accumulations. For the refiner of crude oil to carry his refining process to the extent to which it is carried in the crankcase of a car would be economically unfeasible.

The re-refining of used oil generally follows the pattern of either the steam distillation process or the newer, lower temperature, vacuum distillation process, both of which are used by the petroleum industry to refine crude oil. The steps in both processes are essentially the same, except for the temperature and pressure at which distillation and fractionation occur. Basically the steps may be broken down as shown below: removal of water and solid particles by dehydration and settling; sulfuric acid treatment to precipitate gums, grease, and other matter; alkaline treatment to neutralize acid compounds; water wash to remove soaps formed in neutralization; mixing with special clays such as Fuller's Earth to bleach the oil and absorb certain impurities; distillation to drive off light ends, moisture, and other volatiles; filtering to remove clay and other solids; and blending to desired specifications and the use of additives.

In the re-refining process 75 to 90 per cent of the drainings to be processed are usually recaptured as good oil. The oil may be re-refined many times. Some oil in Greyhound buses has been lubricating pistons for 200,000 miles. The process, while removing the impurities, usually removes all traces of additives put in by the refiner of the crude oil. In most cases only fifty per cent of the original amount of additives has to be added to the re-refine doil to produce an oil of the same quality.

Aside from the prevalent misconception that oil wears out, re-refiners have other false ideas to overcome. The confusion existing between reclaimed and re-refined oil and the tendency to identify the two as one has hurt the re-refiners' business. Reclaiming methods are incomplete and inadequate, and are often based solely on the removal of visible solids. Various methods of filtration, such as through earths, sands, sawdust, papers, rags, fibers, porous blocks, and the use of centrifuges have been tried to obtain this removal. Since many of the harmful impurities found in used oils such as moisture, diluents, tars, and resins can not be properly extracted by filtration, reclaimed oils have not been able to live up to the impossible claims made for them, resulting in prejudice against re-refined oil. With proper re-refining these aluterants and diluents are eliminated, giving the used oil the body, viscosity, viscosity index, and other properities of new oil. The viscosity index is a measure of the degree of change of viscosity with temperature changes, a high index indicating a small amount of variance. A good quality light or medium weight oil will have a viscosity index of 90 or above.

Another problem faced by the re-refiner, which is of more concern to the average motorist than to the commercial user, is a disbelief by the buying public in the re-refiner's ability to produce an oil of consistent quality. With the commercial used he does not face this problem, since the oil he receives from the is usually of a standard quality to begin with, has generally been used in a similar manner each time, and is most likely removed after a definite

period of service. The re-refiner then treats each batch separately as it arrives. Furthermore, the commercial user sets specifications and usually has a means of periodically testing the re-refined oil to see that these specification are met.

However, the re-refined oil that the motorist buys at the local filling station has had varied backgrounds. It was picked from a garage pit where all types of oil were dumped, where the best and the poorest grades have been intimately mixed. It is hard to believe that out of this hodge-podge the re-refiner can produce an oil day after day with consistent qaulity. Yet that is exactly what he does.

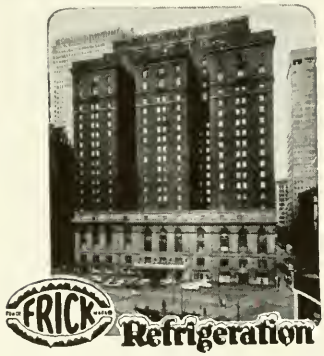
Although crude oil may be either an asphalt base or a paraffin base oil, many oils are a mixture of the two and the main difference between brands and the various grades of new oil is the degree to which refining has been carried out and the amount of additives used. The refining process that takes place in the crankcase of the car tends to equalize the differences in the degree of original refining, and the re-refining process removes all the additives. This means that the re-refiner can depend upon a fairly consistent product and can count on making up any differences by the amount of additives that he uses. Also, the re-refiner has found that he can depend upon collecting from the filling stations a mixture of oils having a fairly constant content. Thus he is able to standardize his process to some degree.

The above facts still give the motorist no assurance that he can depend upon consistent quality from the same re-refiner, since the re-refiner is able to produce oils of all grades. But so is the refiner of crude oil. Yet we have come to rely upon his ability and integrity, and we choose our oil by brand and grade without any doubts. Being relatively new in the field, the re-refiner has not yet been able to build up a reputation. Realizing this, the Association of Petroleum Re-Refiners, with headquarters in Washington, D. C., has prepared a list of specifications, which must be met by the re-refiner before he can carry the seal of approval of the Association on his product. Because of the exacting specifications thus met, a re-refined oil carrying the seal of the Association of Petroleum Re-Refiners is probably more consistent in quality than new oil from a certain refinery. The association is also willing to answer questions in regard to individual re-refiners.

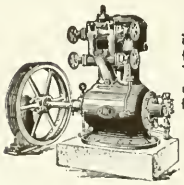
Outside of its advantages to the immediate consumer, re-refined oil serves us in other ways. Re-refining of oil is a means of conserving one of our most important natural resources—crude oil. Estimates on savings by using re-refined oil have shown that aircraft and engine manufacturers save about 60-70 per cent of their total oil requirements while airlines save less than 20 per cent. The reason for this is that because of frequent drainings after their numerous tests, manufacturers discard more oil than they burn.

Crankcase drainings are all too often dumped into city sewers, left to be collected by city sanitation facilities, or poured into rivers and streams. The U. S. Fish and Wildlife Service and numerous state and local authorities have found that dumping of used oils causes serious river and stream pollution with resulting injury to fish and other wildlife, and hazards to and interference with navigation. Before re-refiners located in the Washington, D. C., area collected most of the city's oil waste, it cost the city tens of thousands of dollars annually to collect and dispose of these used oils. Now the taxpayers need no longer finance this operation.

It is not hard to see why re-refined oil is becoming more and more accepted by the average consumer. An estimate of the saving to the U. S. public already afforded by the collection of used oils by re-refiners amounts to approximately $5,000,000 per year. With all these accomplishments to its credit, re-refined oil is fast making a name for itself in the petroleum industry.



Provides Five Services for Hotel William Penn



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LEE de FOREST

by Don F. Kesler, E. E. '56

Wireless telegraph, wireless telephone, radio, audion, amplifiers, and sound on film movies were only a few of Lee de Forest's inventions. The patent office issued the rights of an inventor to Lee de Forest over 200 times.

After receiving his doctor's degree from Yale in 1899, Lee went to work in the experimental laboratory of Western Electric. At night he continued the work of his thesis, "Reflection of Hertzian Waves from the Ends of Parallel Wires," pursuing the lines of wireless telegraph. He searched physics journals and conducted the existing experiments of the Marconi wireless telegraph.

In April, 1899, *Wiedemann's Annalen*, in an article by Aschkinass he found a brief description of a newly discovered detector. A piece of tinfoil was laid upon a piece of glass and cut with a razor. When a battery and telephone receiver were connected to the terminals and a drop of water was placed over the gap, a sound could be heard when a spark generated electric waves in the vicinity. This was exactly what he was looking for. Work began on the "Responder," de Forest's first detector.

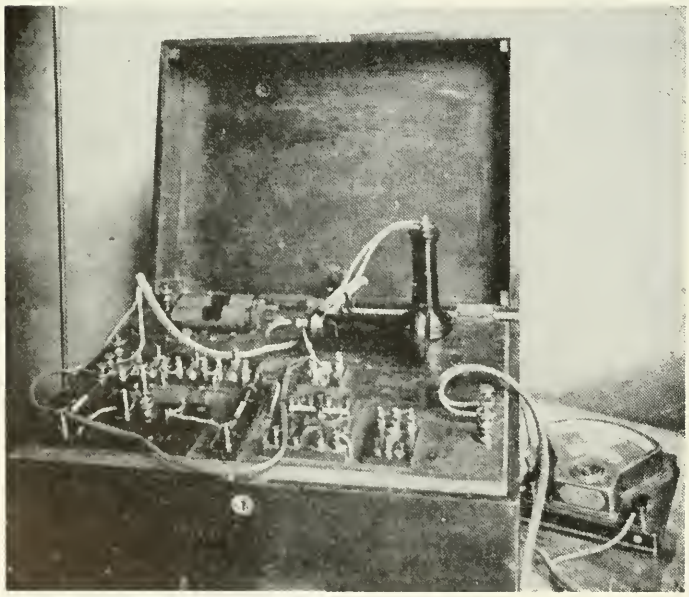
Professor Johnson, owner of the Johnson Pneumatic Heat-Control System, came to Chicago and offered de Forest a job with his company. He accepted the offer at fifteen dollars a week. Immediately he began working on Johnson's perfectly impractical system of receiving wireless messages. After several weeks of waiting, hour on hour, for the signal to come through, Lee was thoroughly disgusted with the Johnson detector. One day he brought the Responder to his end of the work. Within an hour he was steadily picking up the signal.

Lee decided to give more time to his responder, so he quit his job and began working half time for *Western Electrician*.

After a lot more work and research, a company was formed. In 1902 the American De Forest Wireless Telegraph Company was thriving. A new alternating-current transmitter was developed with amazing success. The company began building sets and some were sold to the Navy and others to the public.

During the Russo-Japanese war, the *London Times* continually scooped the other newspapers by days. Lionel James equipped a small dispatch boat with wireless. Once during his adventure his boat was being approached by the Russian cruiser, Bayan. Seeing the danger, he telegraphed the *Times* to notify the British Consul if he was not heard of within three hours. When the Russians boarded and saw the message he had sent and received, they immediately let him go.

Lee de Forest, the first disc jockey, at one of his broadcasts.



Early Responder, the wireless telegraph and radio receiver

Thursday, April 6, 1906, wireless had been sent across the Atlantic. With little change other than more transmitter power, wireless had been sent across the ocean.

The greatest advance in radio yet today was the invention of the Audion. The three electrode vacuum tube was the first amplification in history. The Navy rejected the use of Audions in their recievers, so this stopped the development of this marvel for a year.

Late in 1906, Lee de Forest designed the carbon arc transmitter, thus wireless telephone was here. He began transmitting and asked all telegraph operators who might hear it to telephone his laboratory, so that he might know that he was heard. (All the wireless telegraph receivers were using telephone earphones to head the sound. They were exactly the same as the radio receivers to be built later.) Again attempts were made and records were broken for the maximum distance for radio broadcasts.

Lee de Forest's dream was realized when the Metropolitan Opera went on the air. In the winter of 1909, Lee went to Andreas Dippel, the assistant director, who possessed vision and enthusiasm for the project. Together they put a transmitter in the attic and brought Caruso to the masses.

In 1912 work was begun on an amplifier. After three weeks of building

and rebuilding Audion's and Audion circuits, a small, but comforting amount of amplification was gained. He connected the plate of one Audion through a transformer to the grid of another and found he could amplify electrical signals. By connecting them in series of two or three, he could get a larger gain. He kept working until the threshold of hearing was two blocks from his "loudspeaker." Demonstrations were made for American Telephone and Telegraph Company, and Western Electric. At one time during the experiment he had only one Audion, and hooked the plate to the grid to try to make the tube do the job of two. In trying to obtain self-amplification, he got self-regenration, or in other words, self-oscillation. Thus we have regenerative radios and transmitters.

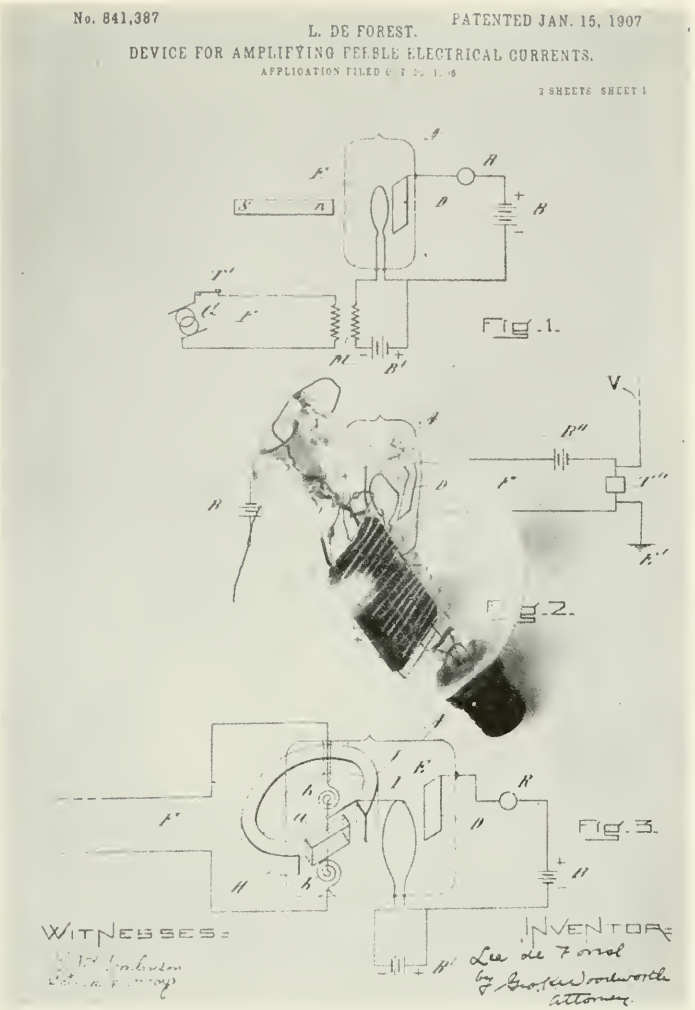
A. T. and T., through a go-between agent bought the wire rights for seven Audion patents for $50,000. Actually the company had voted to go as high as half a million dollars for the patents. They had bought the rights to make amplifiers and use them for telephone and telegraph for only $50,000.

The Ultra-Audion circuit was discovered by accident. The B battery was connected directly to the plate, with the radio-frenquency inductance and variable condenser in shunt, connected across the grid and plate electrodes of the tube. The Ultra-Audion circuit was used for several years after that.

The Marconi Company brought suit against the De Forest Company on the grounds of infringing upon the Fleming valve patent. All the patents were made to cover as much ground as possible, but the Marconi Company was trying to stretch the Fleming valve patent to cover amplification. (It was proven in the Supreme Court in 1943 that the Fleming valve was merely a rectifier and no amplification was made.) The De Forest Company filed counter suit because they were infringing upon the three-electrode Audion tube patent.

When Marconi admitted the validity of the Audion patents, the Honorable Judge Julius Mayer said, ". . . . these parties came into court and in forthright and manly fashion admitted their sins. They should not therefore be punished for so doing. Injunction is denied!" The court then ruled that the De Forest Company had infringed upon the Fleming valve patent. Immediately they appealed the case, and two years later, they lost the appeal. As a result of the case the radio tube industry was a hopeless mess until the Fleming valve patents ran out in 1922.

Don Kesler is a sophamore in Electrical Engineering. Besides his school work and the Technagraph, he works on meters in the Instruments Laboratory in the Electrical Engineering Building. Don is a permanent resident of Urbana.



The Audion Tube patent is considered one of the most important issued

In 1921, Lee de Forest found new worlds to conquer. Edison had synchronized phonograph and movies to attain "talkies," but he had poor success. Earlier de Forest had tried it with steel telegraphone wire. Now he thought it could be done with light, photographed on the film. He made his first talking movie in June, 1921. The first theater preview of sound films came two years later with Eddie Cantor in monologue and Lillian Powell in her graceful bubble dance and lovely music. Photofilm, sound on film movies, was hard to sell until "Don Juan" was produced in 1926. Then the battle for the patent rights begun.

During the greater portion of his work, Lee de Forest was struggling hard to get the finances to produce his inventions. His greatest invention, the electron tube, has brought over a billion dollars to the patent owner. Of this he received less than a million dollars, less than one tenth of one per cent. Less than one per cent of radio listeners and television viewers know who made it possible for them to listen to the Metropolitan Opera in their home.

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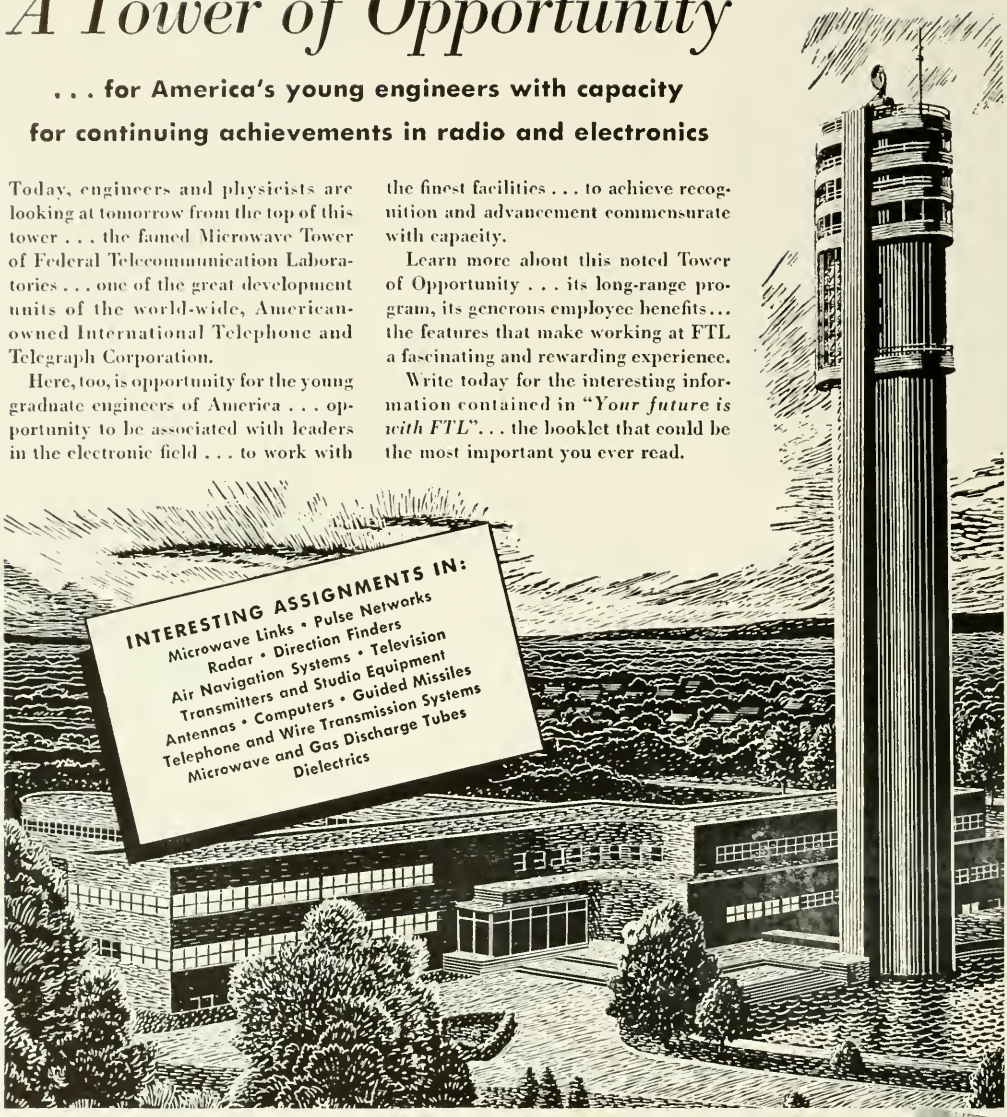
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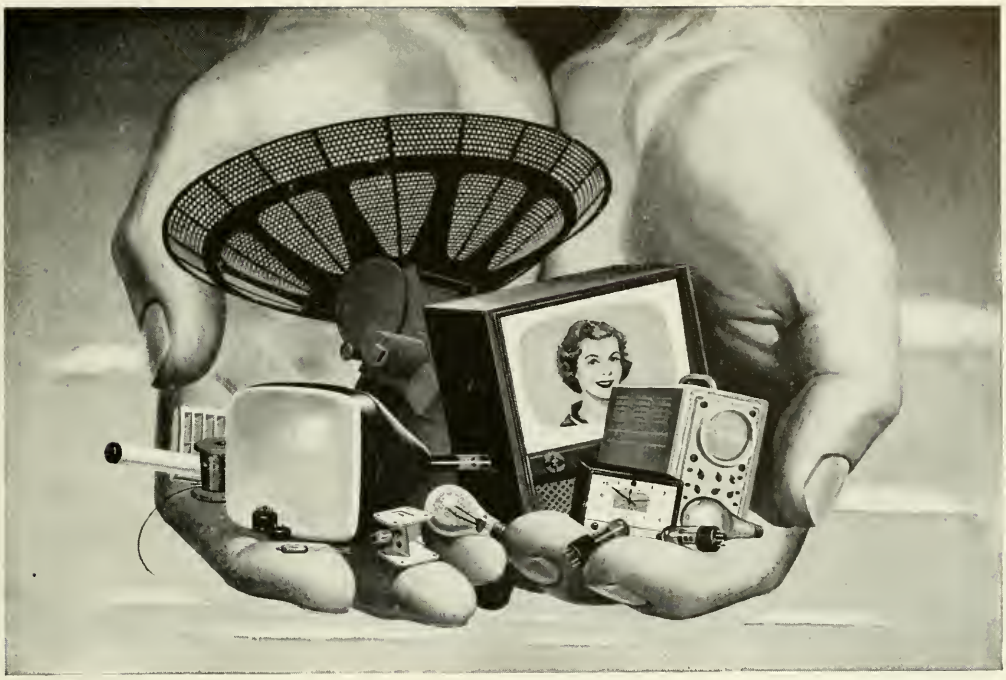

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MULTIPLYING ELECTRONS

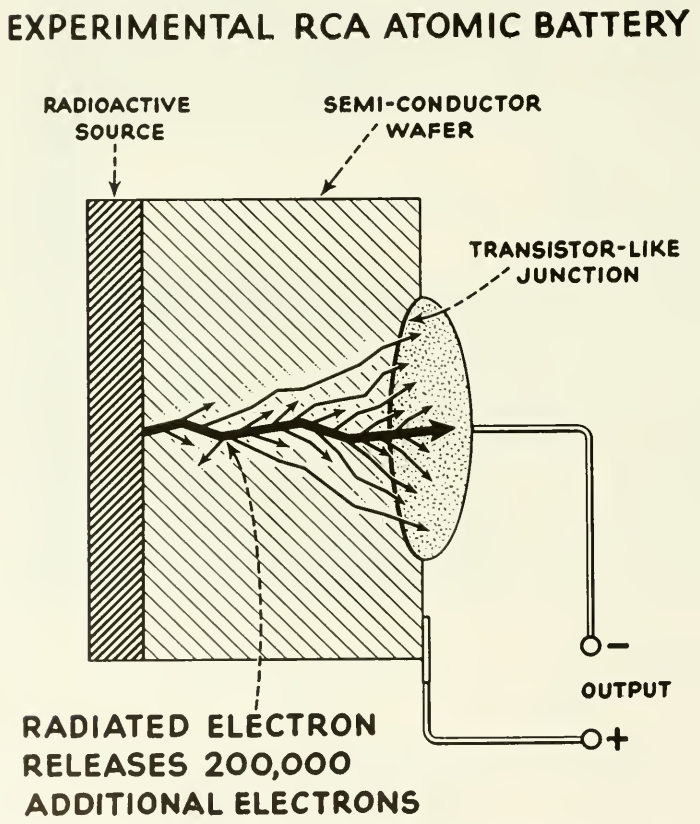
edited by Don F. Kesler, E.E. '56

For more than forty years, science has searched for a practical way of converting radiations from the atom's nucleus to electricity. Though research is far from completed, successful operation of the atomic battery represents a major breakthrough toward that goal.

The conversion of nuclear energy into electricity is achieved by an experimental atomic battery, powered by a minute quantity of a long-life strontium-90 radioactive isotope obtained as a by-product of atomic reactor operation. The electric current derived from this unique atomic battery exceeds by many times all previous results attained in attempts to generate usable electricity directly from radioactive material.

This big stride has been achieved by coupling the battery's radioactive source to a transistor-like wafer, which instantaneously releases some 200,000 electrons for each electron it receives from the radioactive material.

This development, though still in a pioneer stage, may prove to be the beginning of a new and basic chapter in man's efforts to utilize some of the enormous untapped energies within the nucleus of the atom for peaceful purposes and for the enrichment of human life rather than its destruction. Although it is still too soon to know all the uses to which this direct conversion of nuclear energy might be put, the prospect of an entirely different kind of power source is a particularly exciting one for the electronics industry.



Simplified cross-sectioo view of experimental Atomic Battery. Radioactive source, which is strontium-90 in present version, radiotes billions of electrons (beta particles) per second for many years.

Perhaps as startling an advance as any in connection with the atomic battery is the fact that a single rapidly moving, electron, emitted from the radioactive atom, produces no less than 200,000 slower electrons in the bombarded semi-conductor. It is this extraordinary multiplication in the number of available electrons which promises to make the atomic battery a usuable device of practical significance.

Progress in increasing the efficiency of the atomic battery has been rapid during the past few months and is expected to continue. Results to date indicate the possibilities of producing thimble-size, atomic batteries. When these experimental batteries are developed to a commercial stag, they can supply power for radio receivers and other kinds of electronic appartus, without replenishment or attention for at least twenty years.

The atomic battery is likely to be applied first to miniature devices such as portable and pocket-size radio receivers, hearing-aids, signal control, and similar devices that require reliable power sources with great length of service.

As we learn how to produce atomic batteries with more power than is obtained from present experimental models, it may be possible to use them for operating portable short-range transmitters for radio telegraph and telephone communication and radio beacons for navigation by air or by sea.

Of great importance is the fact that such atomic batteries will be highly compatible with future equipment using transistors. Both the battery and the transistor have the potential advantages of compactness, ruggedness and long life.

Until recently, radioactive battery devices produced, at best, a billionth of a watt of power under conditions suitable for transistor operation. Today, with

Magnified model of the two basic elements of experimental Atomic Battery, which makes it possible to convert atomic energy directly into small but usable quantities of electrical energy.

only a small amount of radioactive material, single atomic battery provides a millionth of a watt—enough to run a transistor audio oscillator circuit. This gives a tone that is audible twenty feet away. With more radioactive material, a number of these "one-cell" devices could be stacked in a single case to produce a larger output.

Strontium-90 is not now obtainable in completely purified form, that is, other fission products have not been entirely separated from it. Since some of the unwanted radioactive materials are emitters of gamma radiation, shielding is necessary in the laboratory device.

However, strontium-90 in purified form, emits only beta particles which, for the quantities that would be used in a small atomic battery, does not raise problems of shielding.

Strontium-90 costs about 50 cents for a thousandth of a curie today. The radioactive material for today's atomic battery would cost $25.00. A wide demand for the material in atomic batteries and other applications would warrant quantity processing of the material. This, it has been estimated, might bring its price down as low as two-tenths of a cent for a thousandth of a curie, or 10 cents for a battery.

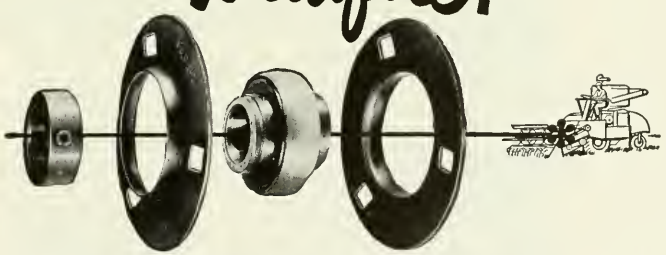
An aspect of atomic batteries that has yet to be determined accurately is the extent of the effect of the beta radiation on the crystal wafer. It is known that the crystal structure of many substances is gradually damaged by bombarding electrons. Further research is in progress to minimize these effects so as to make them neglibile for the structures used in the atomic battery.

This new and distinctive approach to the harnessing of the atom's energy for peaceful purposes is most timely. This is a big step toward the atomic peace proposals President Eisenhower laid before the United Nations on last December 8th. These proposals for international development of the peaceful uses of the atom are now being discussed between nations and are much in the public mind.

No one can look far enough ahead to see all the ways in which a new principle or scientific method will find practical application. Some of these, however, we can anticipate, such as providing small quantities of power at low voltage for various kinds of electronic devices where extreme compactness, ruggedness and long life without attention are important factors. But when we deal with something as basic as capturing the energy of the atom and turning it directly into electricity, the first practical applications may not foretell the full scope and range of its future usefulness.

The history of science and invention presents many notable examples of scientific progress of which the atomic battery is the latest. When Michael Faraday first produced an electric current it was with a relatively simple device: a copper disk rotated between the ends of a magnet. Faraday—120 years ago—did not visualize the future of his invention, yet, today, the huge power generators at Niagara and the Hoover Dam operate on the same basic principle of Faraday's discovery. Who knows what we can operate with atomic batteries?

The idea that caught like *Wildfire!*



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The Earth Goes Around!

NICHOLAUS COPERNICUS

by Donna Rudig
Eng. Phy. '57

NICKOLAUS COPERNICUS

Mathematician, theologian, astronomer, and medical man—Niklas Koppernigk, son of a Polish wholesale trader and German housewife, was all of these. He shook the foundation of the early Rennaissance Period's belief in the Ptolemic Universe and planted the seeds for our modern version of the solar system and its movement.

In 1946, when he was 23 years of age, Koppernigk journeyed to Bologna to study Canon Law and to follow the lectures of Domenica Maria Novara, the astronomist. The next year, the Jubilee year in Rome, he was elected Canon. Also during this time he taught in Rome as a professor of mathematics; but in 1501 he gained leave of absence so that he could continue his academic career and entered medical school at Padua. He left Padua in 1505; but meanwhile, in 1503, he had received a doctor's degree in Canon Law at Ferrara.

Returning to Poland, Koppernigk resided at the Epicopal Palace in Hilsberg as his uncle's physician until the bishop's death on March 29, 1512. He then went to Frauenburg where he acted as chapter representative under harrassing administrative and political conditions. Also he was commissary of the diocese of Ermeland. Much of his time he spent in giving medical service to the poor although he was often demanded by the rich. In 1522 he devised a plan to reform the currency and presented it before the Diet of Graudeny.

Ever since the time of his professorship in mathematics at Rome, Koppernigk had become interested in astronomy and, through observations and calculations, became convinced that the Ptolemy theory of the earth being the center of the Universe was wrong. According to his heliocentric theory, Koppernigk believed that the earth revolved about the sun once a year, the earth rotated every 24 hours on its axis, the sun was the stationary center of the Universe, the planets revolved in uniform circles about the sun, and that the earth rotated from west to east. Since these ideas were so revolutionary to the ones of that time, and he could offer no valid proof for them, Koppernigk hesitated to declare them publically. However, these ideas circulated among his friends and fellow astronomers by means of letters and word of mouth.

About 1530, when he was sure of his theories, Koppernigk prepared a manuscript, *Commentariolus (Little Commentary)*, to give to his friends. Although Cardinal Schönberg gave Koppernigk a formal demand to publish his theories, it was not until 1540 that friends finally persuaded him to consent to do so. George J. Rheticus printed his book, *De Revolutionibus Arbium Colestrium (Concerning the Revolutions of the Heavenly Bodies)* in 1543.

Toward the end of 1542, Koppernigk was struck by apoplexy and paralysis. The first copy of his book barely reached Fraunburg in time to be placed on his death bed, saving him the disappointment of knowing that the book had been marred by a preface stating that all the material in it was purely hypothetical. Koppernigk died on May 24, 1543.

In later years Johannes Kepler described Koppernigk as "Copernicus, vir maximo ingenio, et quod in hoc exercitio magni, momenti est, animo liber" (a very approximate translation would be "Copernicus, man great in size, and whom in this great practice, is influential, a book in his mind.")

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From the Phone to

THE COVER

by Dave Templeton

F.A.A. '55

"Hello, Dave. This is Howie Hadler," said the voice on the other end of the phone. "I've got the assignments and articles for next month's issue."

"Just a second while I get a sheet of paper and a pencil. Okay, shoot."

And this is the way a Technograph cover and the spot drawings for some of the articles start for the magazine you are now reading. Howie Hadler, our associate editor, gives me a call, tells me what the articles in the next issue are, and if they don't have anything specific to feature, it's up to this individual to pick the one that will lend itself to the best design.

Being in art school, most of the engineering subjects don't have half the meaning or familiarity to me as they do to the engineer. In a way, this is an advantage, because if the cover is to appeal to someone who isn't an engineer but is a little interested in the subject, I feel that to throw him a complicated photograph would make him shy away from the magazine . . . which is the first thing we don't want to do.

But yet, this is an engineering magazine. Consequently, I can't draw a cover from what I know about the subject. Because, believe me, as I mentioned before, my knowledge is very little. And if there's anything more annoying to a person looking at a picture, it's one that has obviously been drawn without very much of an idea what the subject is all about.

So, the next step in this phone-to-finished-drawing story is either a trip to the library or a talk to the person directly connected with the article. It's at either of these sources that I make sketches and talk to someone who can tell me just how the subject which I am drawing effects you and me . . . the citizen . . . the laymen (if you aren't an engineer). All of this goes into a sketch pad which is generally never out of my possession. This is because at times I can sit and try to get an idea and it doesn't come. But suddenly it pops into this thing I laughingly call a brain and I might be in a class or even walking down the street at the time. An idea can pop out of the mind as easily as it pops in. So, it's best to get the idea down quickly before it's forgotten.

The many-time-mentioned idea is on layout and a way to tie the engineering end of the illustration up with a familiar scene . . . the aforesaid way the subject effects Mr. and Mrs. Citizen.

After making some preliminary sketches and finally working it down to almost a finished drawing, I start on the final drawing itself. This is done on a piece of 15"x20" illustration board (but the drawing is actually 12¾" square which is reduced to magazine size by the engraver). The entire drawing is done in blue pencil because there is no danger of the photoengraving apparatus picking up black marks left by a too heavily pressed graphite pencil. What I want printed is finally inked in with India black ink. The blue pencil marks, which I don't ink in, can be left on the drawing without fear of being reproduced.

With a two color cover, such as those we've been using this year, two drawings are required . . . one for each color. The way the two drawings are matched up is very simple. I take a heavy sheet of tracing paper and put it on top of the drawing which has been entirely drawn in blue pencil and then trace off what I want in the other color and then ink that in. The first drawing has only that part inked in which I want for it's own particular color. The very last thing is putting cue marks on, which are nothing more than little circles with crosses inside these are put outside of the illustration at each corner of the original drawing and then traced off on the second one. This is so that the final metal plates can be matched up and you won't have one color over-lapping another like you find in the comic section of your Sunday paper every once in a while. Then I write on each plate the color I want them to be printed in.

The engraver takes over now. He takes a reduced photo of the drawing on metal. He spread an emulsion on, which sticks to only the part that is the photograph. He dips it in an acid which eats away the exposed metal, doing this for a short interval several times or the acid would start eating away under the emulsion.

That's about all there is to it. The printer runs each plate through the ink I asked for and you have your cover. The next step is yours. You buy it, look at it . . . and I hope notice the cover (with a favorable impression). When the drawings leave my hands my fingers are constantly crossed. I know pretty well what it's going to look like, but there is nothing like the finished, printed thing.

So, I sit back, relax and sigh, "Another one finished." Then the phone rings. I pick it up and the voice at the other end says, "Hello, Dave. This is Howie Hadler. I've got the assignments and articles for next month's issue." And I start again.

tandards

and ozone resisting properties of the insulation, the construction details of the cables and the thickness and other properties of the covering or sheath. These specifications are issued by literally hundreds of manufacturing organizations, municipalities, railroads, utilities, government agencies, etc. They may differ only slightly but significantly, in certain details, thus making it necessary to run many wires on special orders. The wire and cable industry is thus obviously specification conscious. In fact, it is probably true that all types of wires and cables used today are more completely covered by specifications than any other class of commercial products of equal complexity.

Specifications have thus become a necessary and important part of the wire and cable industry. When properly prepared on the basis of sound engineering, information and manufacturing practices, they provide for durable, economical and safe cables for any particular application. They describe the item in a clear and concise manner that can be readily understood by any one familiar with the industry. They form the basis for contracts between cable users and cable manufacturers, and eliminate or minimize any questions that might arise concerning the construction or quality of the cable under consideration. A working knowledge of wire and cable specifications is essential for those interested in the development, manufacture and use of wires and cables.

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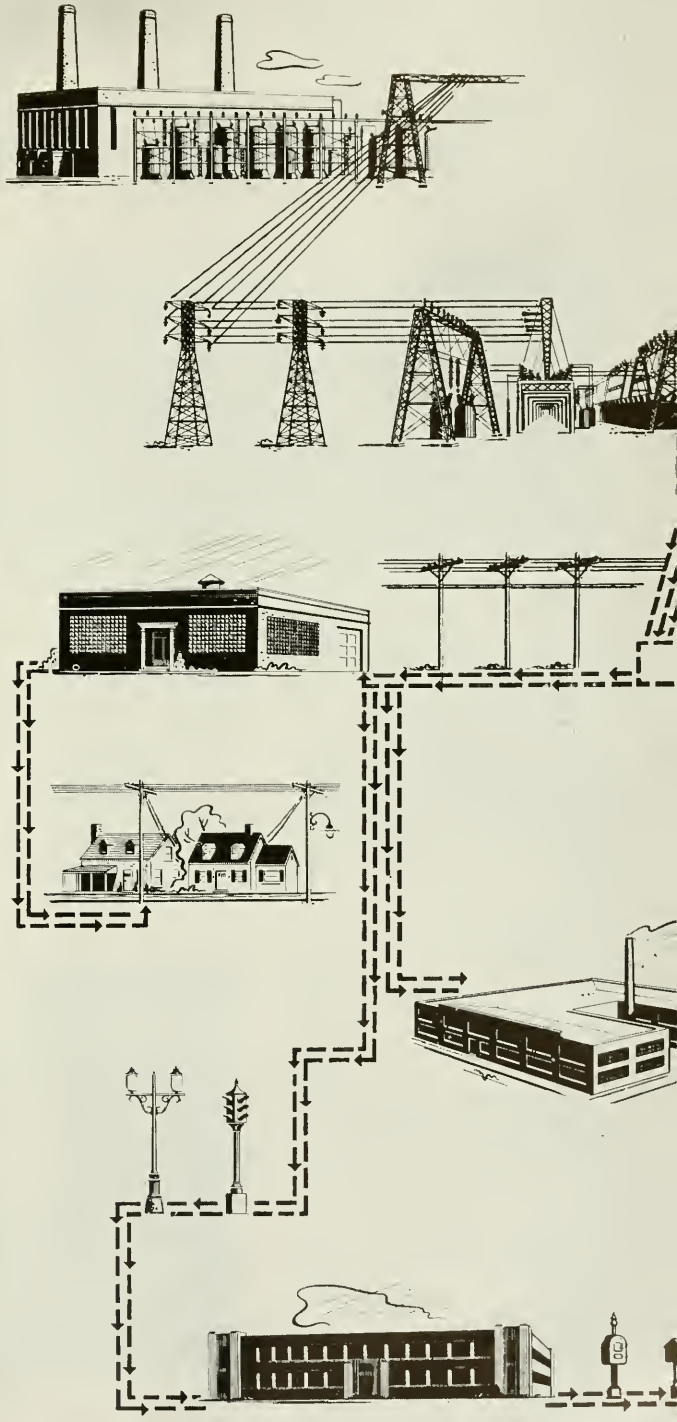


The Machine with a Memory

(From National Bureau of Standards)

Recent Developments and Operating Experience

SWAC—the National Bureau of Standards Western Automatic Computer—is now being operated 24 hours a day, five days a week to solve a wide range of complex problems in physics, engineering, mathematics, statistics, and meteorology. At present over 70 per cent of this time is devoted to problem solution, the remainder being reserved for maintenance, engineering development, and testing of new equipment.

SWAC is a general-purpose digital computer constructed by NBS in 1950 under the sponsorship of the Wright Air Development Center. The first of the high-speed electronic computers to be completed with the very fast Williams tube (cathode - ray tube) memory, SWAC operates at a rate of 16,000 addition or 2600 multiplications per second.

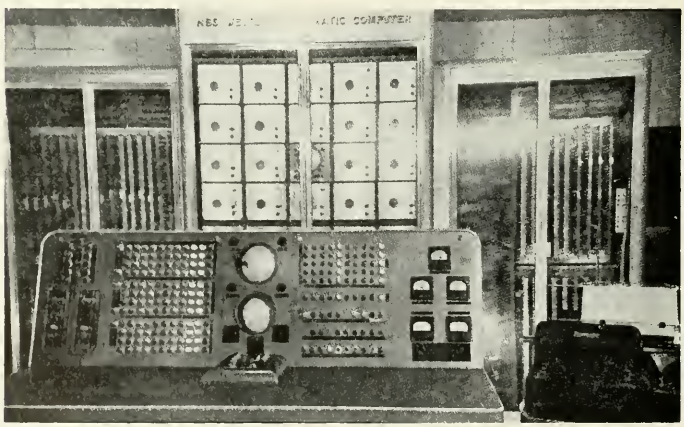
Recently the scope and complexity of the problems which the machine can handle have been greatly extended through the installation and successful operation of a magnetic drum auxiliary memory. Based on the principle of the magnetic-tape recorder, the new memory holds 16 times as much mathematical information as the cathode-ray tube memory, with which it will be used to increase the over-all memory capacity of the machine. The magnetic drum will also act as a storehouse for a library of numerical methods or routines of instructions which, when obeyed by the machine, can facilitate the solution of a large class of problems.

SWAC was designed and built at the NBS Institute for Numerical Analysis in Los Angeles to provide a rapid, powerful computational tool on the West Coast and to aid in the Institute's program for the further development and increased utilization of the art of machine computation. The ultra high-speed machine has been used by NBS principally to solve aircraft problems originating with the Air Force and its contractors, other problems in science and engineering submitted by Government agencies, and mathematical problems arising in connection with the Bureau's work on computation methods and computing machine development.

SWAC's high speed results from its special Williams tube memory and its parallel mode of operation. The memory unit consists of a bank of cathode-ray tubes which store information as bright spots of charge. The unit is operated in parallel, that is, all the digits of a number are transferred in or out of the memory simultaneously, thus greatly reducing the time required for transfer of information. In serial machines, such as those using acoustic-delay-line memories, numbers and instructions are represented by trains of electrical pulses. But in SWAC parallel circuits transfer numbers and instructions almost instantly, within the time of a single pulse (about one tenth of a microsecond). Arithmetic operations are also carried out in parallel, with a consequent increase in speed of computation. In its parallel method of operation SWAC differs from SEAC (National Bureau of Standards Eastern Automatic Computer), a serial machine constructed by NBS at its Washington (D. C.) laboratories.

Magnetic Drum Memory

While the cathode-ray tube type of memory delivers information at a very rapid rate, its capacity is limited by the number of digits that can be stored on the face of a single cathode-ray tube. To provide greater flexibility and computing power, a magnetic drum external memory was developed by Thorensen and associates of the NBS staff. With the drum memory, many complicated types of problems can be handled by transmitting information out of the computer for storage and then feeding the



The main SWAC computer, control consale, and input typewriter. (This computer is very similar to the one at the University of Illinois, The Illiac.)

information back into the computer at a later stage of the problem.

SWAC's drum memory, like those developed elsewhere, is a revolving metal drum which retains numbers and instructions on its surface in the form of magnetic pulses like those used in tape recording. At intervals, blocks of magnetic pulses are removed from the drum by a magnetic head and are taken into the computer to be transformed electronically into spots of charge in the Williams tube memory, where they remain until called for by the control unit.

SWAC stores and processes information in units called words, each word consisting of 37 binary digits, the equivalent of 11 decimal digits. The magnetic drum has a capacity of 4096 words of 37 binary digits each, in contrast with the 256-word capacity of the cathode-ray tube memory. This high-capacity memory makes possible the solution of very large sets of simultaneous equations, such as arise in logistics; certain types of partial differential equations which occur frequently in aeronautical research, in heat-transfer problems, in electro-magnetic theory, and in other fields; and combinatorial problems, applications of which have recently engaged the attention of scientists. Instruction routines stored on the drum will handle, among other things, the conversion of information from a decimal representation into the binary representation used by the machine, as well as the final conversion back to decimal form when it is required to print out results.

In the construction of the magnetic drum, primary consideration was given to simplicity of design and maximal efficiency in the transfer of information between it and the cathode-ray tube memory. A drum memory ordinarily has a much larger capacity than a Williams tube memory, but access to a drum memory is generally slow. In particular, if information is required from some specific location on the drum, the computer may have to wait up to a maximum of one drum revolution before receiving any information. However, in the magnetic drum memory developed for SWAC, access time is shortened in two ways: (1) Numbers are transferred in sizable blocks from the magnetic drum memory to the cathode-ray tube memory, thus minimizing the total number of times the drum memory must be consulted. (2) The numbers in each of these blocks are stored sequentially around the circumference of the drum so that one block forms a band or channel completely encircling the drum. When a transfer to or from the drum memory is made, the whole channel is handled at one time. Transfer of information starts immediately after the proper channel has been selected and continues for exactly one drum revolution thus eliminating all waiting time. In this way the access time per word is reduced to 500 microseconds—about 1/30 of the normal access time of a magnetic drum memory.

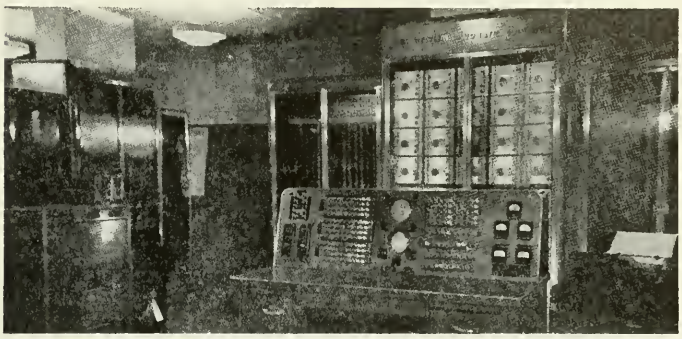
Information is stored serially on the drum in 40-binary digit words. The first 36 digits represent numerical information, the 37th digit gives the algebraic sign, while the remaining three digit positions are empty. Thirty-two words are stored in each channel and constitute a basic transfer block. As the drum rotates at 300 revolutions per minute, 32 words are transferred in approximately 17 thousandths of a second.

The drum contains 128 information channels plus four timing channels. The timing channels feed a timing generator, which generates a pulse for each digit space, a pulse for each word space, and a reference pulse for each revolution of the drum. The pulses marking each word space go to an *address counter*, which counts from 0 through 31. This counter continuously keeps track of the word space as they pass under the magnetic read-write heads. The reference pulse is used to initially synchronize this counter with the drum.

The cathode-ray tube memory operates in parallel with the serial magnetic drum memory, and the two are not in synchronism. Direct communication between the memories is therefore not possible. Information from the drum must first be played back into a vacuum-tube shifting register and then transferred in parallel to the cathode-ray tube memory. Each digit takes 13 microseconds to play back, so the three empty digit spaces in each word give total delay of 39 microseconds between words. This delay is more than adequate for transferring a number from the register to the cathode-ray tube memory and for clearing the register to receive new information.

The entire drum memory system consists of less than a dozen different types of basic single-tube plug-in units that are developed to a high degree of stability under a variety of conditions of loading and aging. Only about 250 vacuum tubes are used.

In addition to the drum memory, plans call for a slow-speed auxiliary memory consisting of a magnetic-tape unit. It will have a much larger capacity than the other two memories, holding approximately 4,000,000 binary digits, but its average access time will be quite long—about 3½ minutes.



The SWAC system. IBM input equipment and magnetic drum memory unit, at the extreme left. The computer and console are at the extreme right.

Description of SWAC

SWAC is automatically sequenced, that is, it automatically performs all of the logical and arithmetical operations required to solve a particular problem once it is supplied with coded instructions and numerical data. The computer stores in its high-speed memory not only the numbers involved in the computation but also the instructions necessary to perform the computation. This makes it possible for the calculator to use fully the speed of the Williams tube memory, doing complete arithmetic operations in a few microseconds.

The computer proper is housed in a single console approximately 12 feet wide, 5 feet deep, and 8 feet high. It consists of three major parts: an arithmetic unit, a memory unit, and a control unit. Four other parts complete the computer system; they are the magnetic drum memory, the input- output units, the operating console, and the power supply.

The arithmetic unit performs the arithmetic operations of addition, subtraction, and both rounded-off and exact multiplication. It also performs the logical operations of *comparison* and *extract*. Comparison involves changing the course of the computation depending on the relative sizes of two numbers. Extract divides numbers up into parts which the computer can handle in different ways.

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The arithmetic unit receives information from the memory in the form of numbers to be operated upon and instructions as to the nature of the operation. Having acted upon such instructions and completed the operation, the arithmetic unit returns the answer to the memory.

The memory feeds its information to the arithmetic unit in accordance with instructions it receives from the control unit. The control unit consists of electronic circuits which control the operations of the computer proper. This unit takes information from the input unit, directs it to the memory, tells the memory when to send information to the arithmetic unit, tells the arithmetic unit when and where to return answers to the memory, and controls the feeding out of completed solutions to the output unit.

SWAC uses both a punched-card input-output system and a paper-tape system. For card input, the coded problem is punched on a standard IBM card, and the answer is received in the same way. In the paper-tape input-output system, a coded problem punched in paper tape is fed into the machine, and answers are automatically given in typed form by an electric typewriter.

The operating console, an office desk with specially built panels mounted on its top surface, permits the human operator to control the operations of the machine and to watch the machine as it operates. The console is provided with control switches and neon lights which indicate what is taking place inside the machine. Oscilloscope screens make it possible for the operator to view the memory pattern of any given unit of the Williams tube memory.

SWAC is supplied with electrical power, carefully regulated in voltage, by means of a motor-generator set and related equipment, largely electronic in nature. The computer is thus isolated from line voltage fluctuations which might affect its operation. About 30 kilowatts are consumed when the machine is operating.

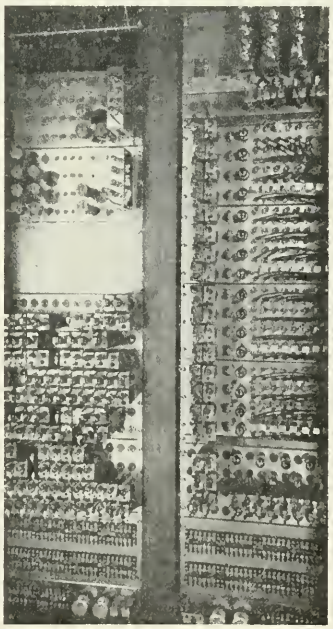
Williams Tube Memory

The Williams tube memory consists of a bank of 37 cathode-ray tubes, each of which can store 256 digits on its face in a matrix pattern of dots and dashes. The dots represent "0" while the dashes represent "1". As SWAC is a binary machine, all decimal numbers and instructions are fed into it in a code which utilizes only the digits 0 and 1.

The number of digits that can be stored on the face of one cathode-ray tube determines the number of words that can be stored in the memory. That is, the nth cathode-ray tube stores the nth digit of each word. Thus, a given word has one digit stored in the same relative position in each of the tubes. This makes it possible to position all of the electron beams at a given location, or *address*, in the memory and thus to transfer all of the digits of a word simultaneously. As a result, the time required to transfer a word to or from the memory is only 16 microseconds.

To produce either a dot or a dash at a given spot on the face of a Williams tube unit, the electron beam is turned on to produce a spot of charge on the screen. If the beam is left on only long enough to establish equilibrium and is then turned off, a dot is produced. If the beam is left on longer and is deflected from the dot position by the superposition of a small sawtooth voltage on the positioning voltages, a dash is produced. The dots and dashes are read off by an amplifier, which picks up the signal from the tube screen, amplifies and reshapes it, and causes the electron beam inside the tube to place a signal back on the face of the tube.

Unless this type of storage is continually renewed or regenerated, the original charge pattern tends to disappear over a period of time as the charged spots gradually collect stray electrons. Thus, to provide continuous storage, an electron beam is made to inspect successively each point of charge and to energize electronic circuits which, when necessary, restore the charge to its initial value. The regeneration process takes place during short intervals which alternate with the reading-in or reading-out of information in the memory. In this renewal process the machine spends only 8 microseconds on each point of charge on the face of the tube, and complete regeneration occurs 250 times a second. Such a continuous regeneration process makes it possible to store information indefinitely. A crystal-controlled oscillator regulates both the rate of regeneration of the memory and the operations of the arithmetic unit.



Magnetic drum switching matrix and control circuits.

Operating Experience

SWAC contains about 2600 tubes and 3700 crystal diodes. The average tube life is between 8,000 and 10,000 hours. To date, very few tubes have been lost on account of heater failure. The largest percentage of tube failures have resulted from low emission and intermittent shorts.

All electronic components in the computer proper are mounted on removable plug-in chassis, so that faulty operation can usually be corrected by replacing a bad chassis with a good spare. The faulty chassis can then be repaired in the laboratory without loss of computer time. The majority of the plug-in chassis contain an average of 10 tubes each; however, the magnetic drum circuits are built of much smaller units, usually consisting of a single tube.

One of the difficulties encountered with the cathode-ray tube type of memory is "spillover," or redistribution of charge, which limits the number of times the spots adjacent to a particular spot may be read before the spot in question must be regenerated. To mitigate this difficulty, circuits have been installed which eliminate most of the drift in the patterns on the face of the tubes. A substantial improvement in operating time has resulted.

Other improvements have been achieved by rebuilding certain parts of the circuitry which have shown a high out-of-order maintenance time. A substantial improvement in operating time occurred when an air-conditioning unit was installed to maintain the incoming air in the ventilation system at a constant temperature. This minimized the temperature cycling of crystal diodes and substantially decreased their failure.

General operating efficiency has also increased by the addition of a loudspeaker and buffer tube with a plug-in arrangement allowing the operator to "listen" to any of the commands in a problem. For example, an alternate succession of add and subtract commands produces an eight-kilocycle note.

Recently, by addition of one tube and a few crystals, a converting output command was obtained. This command, effective only with the output typewriter and tape punch, converts fractional

binary numbers to octal, decimal, or any other base up to 16.

Problems Solved

During the eight month period ending June 1, 1953, SWAC spent an average of 53.2 hours a week in actual computing. The remainder of the operating time was spent in code checking, memory adjustment, maintenance, testing of components, and development of improved facilities. More than 50 problems were handled in the past year, ranging from minutes to hundreds of hours in running time. During this period the punched-card input-output system was operative, but the magnetic drum had not yet been installed.

Problems in least squares, reduction of data, heat transfer, stress analysis, and a tremendous variety of other physical phenomena can be described by systems of linear equations. However, most of the methods now in common use for solving such equations are variations of the elimination method developed by Gauss. These methods all tend to yield answers of low significance when the matrix of the coefficients is almost unity. Using SWAC for extensive numerical trials, M. R. Hestenes and E. Stiefel of the NBS staff recently developed a new approach, known as the conjugate gradient method, which appears to have broad utility for the solutions of problems arising in applied physics and engineering. SWAC has now solved many systems of equations of order 10 to 15. Codes have been prepared for the solution of systems of any order up to 45, but no system of that high order has as yet been solved. However, the characteristic values and their associated vectors have been found to nine significant decimal digits for a 45th order system, as well as for systems of order 10 to 20.

In the field of differential equations, a large amount of computing time has been devoted to the study of associated Legendre functions, $p_{m,n}(x)$, which are important in mathematical analysis of radiation fields from antennae. The specific problem was the determination of the nonintegral values of the order (n) which, for fixed values of degree (m) and argument (x), would make the value of the function zero. For each combination of m and x, an infinite set of discrete values of n will satisfy the requirements. SWAC found the first 30 values of n corresponding to one value of x and three values of m.

With the aid of SWAC, NBS has carried on research in the application of the so-called "Monte Carlo" method to the solution of complicated differential equation and of previously unsolved statistical problems in nuclear physics. The Monte Carlo method, developed by J. von Neumann of the Institute for Advanced Study at Princeton and S. Ulam of Los Alamos Scientific Laboratory, is a new mathematical technique which solves a physical or mathematical problem by creating an artificial statistical model of the physical or mathematical process involved. It applies the same techniques that are used in analyzing games of chance to the analysis of physical problems where the events are random and are governed by the laws of probability. Large-scale computers such as SWAC provide an excellent means for the solution of problems of this kind because they are able to create conditions which imitate the statistical behavior of the given problem. Thus, the randomness of the event can be taken care of by putting into the extended memory of the machine a set of random numbers which are first tested for their random quality. SWAC has been used to compile large groups of random digits, to explore their statistical behavior, and to investigate their utility for solving partial differential equations by random walk processes. Recently problems concerning nuclear forces have been attacked by means of the Monte Carlo method.

Problems in the evaluation of definite integrals have arisen from studies in probability and statistics. One such problem, the computation of a table of survival probabilities for biological experiments, required the evaluation of 21,500 double integrals with each variable ranging from plus to minus infinity. This table was computed in 177 hours. A second table, for biological experiments in which the exact level of a radiation dose is unknown, required the evaluation of 7500 single integrals, this time with an infinite lower limit and a finite upper limit.

Many applied problems have dealt with the reduction of large blocks of data. A study of the large-scale circulation patterns in the earth's atmosphere was typical. Some 750,000 pieces of data, each five decimal digits in length, were processed to yield about the same number of answers. SWAC spent 325 hours on this problem.

SWAC has also been applied to several combinatorial problems. In some it has exhaustively searched through all possible combinations of the variables. One such problem was that of finding *difference* sets, that is, a set of n numbers such that all n(n-1) nonzero differences give distinct remainders when divided by n^2-n-1. Another problem, involving permutations, dealt with the optimal assignment of duties in an organization.

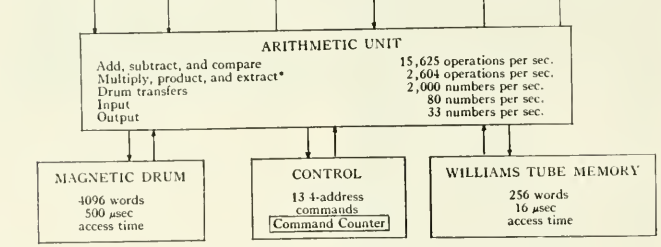
SWAC has proved an effective tool for the analysis of Fourier synthesis of X-ray diffraction patterns of crystals. Such analyses, at present being carried on by members of the Chemistry Department of the University of California at Los Angeles, lead to the determination of the arrangement of molecules inside the crystals.

In the field of pure mathematics, SWAC has been used to study the primality of Mersenne numbers, that is, numbers of the form 2^p-1, where p is a prime. These numbers, when prime, are related to the "perfect numbers" of the Greeks, which are the sum of all their integral divisors excluding themselves. The present list of values of p which yield prime numbers is as follows:

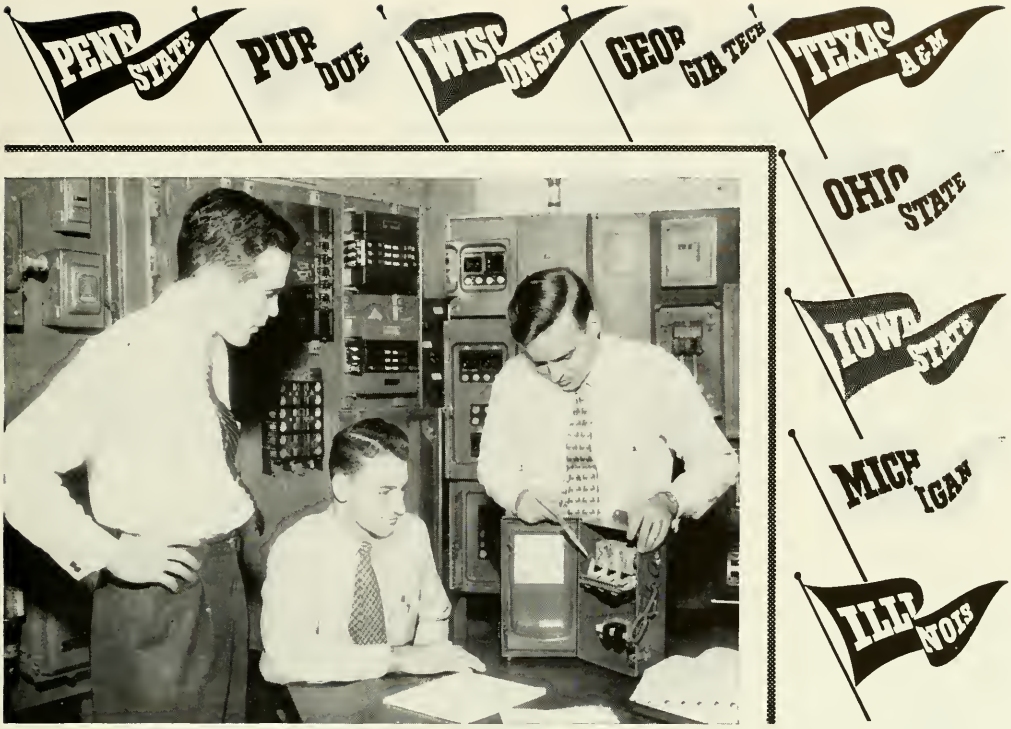
2, 3, 5, 7, 13, 17, 19, 31, 61, 89, 107, 521, 607, 1279, 2203, and 2281.

The last five values were added to the list by SWAC as a result of the systematic testing of all prime numbers up to 2297.

Mathematical research directed toward more effective utilization of electronic digital computers is continuing at the NBS Institute for Numerical Analysis. Further progress in this program should materially increase the scope of the problems which SWAC and other high-speed computers can handle and should also make possible additional savings in actual computing time.



Schematic drawing of the process of the SWAC computer



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SQUARE D COMPANY

by Don Culley, E. Phy. '57, Davida Bobrow, English, Mel Green, M.E. '55

ROBERT TRAPP

Most engineering physicists on campus, in fact most engineers, should have heard of Bob Trapp. He is very well known around the Physics Lab, and can be found there whenever the campus Physics Society is in session. This group, of which Bob is one of the original founders, is probably the most important activity in his busy campus life. He has been doing a very able job as president of this organization for the last two years. A senior in Engineering Physics, Bob is in many other campus activities. He has spent two years on the Engineering Council, and also serves as prexy of this group. He is a member of two scholastic honorary societies: ΣT, junior engineering honorary and ΠME, junior mathematics honorary requiring a 4.75 overall average in mathematics for membership. In addition, he serves as a member of the Executive Committee of the student ASEE (American Society for Engineering Education), and has recently become a member of IRE (Institute of Radio Engineering). In addition to his many activities, Bob has managed to maintain a 3.91 average for a total of one hundred and forty hours.

Bob hails from Taylorville, where he graduated in 1950. He is active there in scouting, in which he holds the rank of Eagle with Bronze Palm, and is assistant scoutmaster of Troop 67, Taylorville.

His usual summertime occupation is either that of lifeguard or instructor in Red Cross water safety, for which he holds a certificate.

In his four years here at school, Bob has lived as an independent. His place of residence has changed recently, however, as he became married to Nancy Holt on December 30 of last year.

At the present, Bob finds himself quite busy filling out job application blanks. If the Air Force does not take him, he hopes to land a job in physics

ROBERT TRAPP

or electronics. Best of luck, Bob. If you keep up the good work you have done here at the University, your future should be very successful.

MEL GREEN

"What can you say about me, Dav? I'm just an ordinary guy." This statement is typical. Mel Green, new Navy Pier *Technograph* editor, is one of the most modest people you could meet.

Although having no previous experience in journalism, Mel joined the *Tech* staff last semester and rose rapidly to his present position. Now in his last semester at the Pier this "ordinary guy" is also publicity director of the Engineering Council, and a member of the ASME and Quad Council. He does all this while maintaining a 4.0 average!

Mel, a M.E. with a production option, plans on coming to Urbana, in September to finish his last two years. If khaki calls, however, Mel will answer. Upon ending his army stint, he hopes to go back to school and obtain a master's degree in Engineering administration.

Summer jobs have given Mel a great deal of practical experience as a draftsman, but his interest lies in the field of engineering sales.

Does he have time for hobbies? Mel admits his greatest hobby, and the one which consumes most of his spare time, is traveling. Five days a week he travels back and forth between and Navy Pier. That doesn't leave too much time for his other past-times which include reading "Mad" comics, science fiction, and photography.

One of the most conspicuous things about Mel is his belt. There is no slide rule dangling from it. Perhaps it's just the non-conformist in him asserting itself.

After knowing Mel for any length of time, you learn his favorite word—Animal. This he uses in the neuter gender, applying the epitaph to male and female alike. The shouted phrase, "Lord, what an animal!" is almost a sure way of singling Mel out in a crowd. To this day, we don't know exactly what "animal" means, but we feel certain it is something complimentary.

The Pier staff will be sorry to see Mel leave, but we know that wherever he goes, and whatever he does, Mel will be successful.

DAVIDA BOBROW

Although her name may tend to be a little confusing, Davida, the Technograph's Business Manager at the Pier, is not to be confused with any male answering to the name Dave. Dav attended Sullivan High School in Chicago where she was Editor of their newspaper, the *Sentinel*, and wrote for their yearbook, the *Navillus*. However, this alone couldn't keep Dav busy. So, she wrote a column for *Meyer's Syndicated Papers*, who are the publishers of many of Chicago's neighborhood newspapers. Dav did a lot of writing both in and out of school. She once won an essay contest by writing about the Illinois State Constitution. She also wrote a few skits and a rhymed narration for a swim show.

It is hard to imagine a person with so much to do looking for something else to do in her spare time, but Dav did just that. Due to the fact that she has always liked water, I suppose it was only

natural that she looked to swimming for fun and relaxation. Fortunately, Sullivan had a Synchronized Swim Club of which Dav became an active member.

In her last year of high school, Dav was in the Senior Play and was appointed to the Senior Prom Committee. With all of these extra curricular activities, one stops to wonder when she studied. Evidently, she must have found the time for she was a member of the National Honor Society, which recognizes

MEL GREEN

DAVIDA BOBROW

student for superior scholastic ability, and upon graduating, she was named one of the outstanding graduates by a Chicago newspaper.

Although now an English major, it is no surprise that Dav was attracted to the Technograph as soon as she came to the Pier, for she has newsprint in her blood. She soon took over the position of Business Manager and all of its many responsibilities with the greatest of ease. Dav is also on the news staff of the *Pier-Illini* for which she writes regularly.

For the few months that Dav has been in college, she has proven herself to be a hard worker, and I know she will excell in everything that she will do here just as she has done in the past.

The two stones most commonly associated with marriage are the diamond and the grindstone.

* * *

An old man marrying a young girl is like buying a new car when you can't drive.

* * *

An experienced stenographer is one who knows how to keep her boss from ending a sentence with a proposition!

* * *

Golf is a game in which a ball 1½ inches in diameter is placed on another ball 8,000 miles in diameter. The object is to hit the small ball but not hit the large one.

* * *

The professor has been lecturing to a very inattentive group: "Class dismissed, and don't flap your ears or bray on the way out."

* * *

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HERCULES

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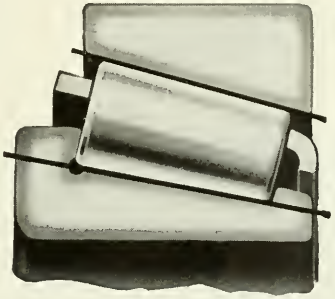
This cross-section drawing shows one reason Timken bearings are ideal for taking the heavy landing load of the plane itself. Note the full line of contact between rollers and races. This gives Timken bearings high load capacity. It's a basic advantage of roller bearings.



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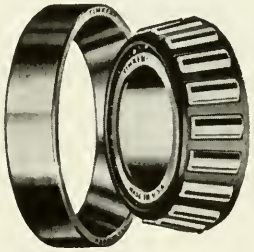

Want to learn more about bearings or job opportunities?

Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

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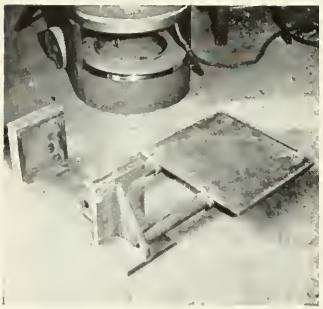

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Architecture

by Dave Webster
Arch. '58

Architecture is a science-art, with twin roots in asthetics and engineering. Unlike painting and sculpture, the architectural work of art (home, school, city hall, bank, church, factory) cannot be brought into existence in the isolation of a studio. True, the building is first conceived and planned in the mind of the architect and then is blueprinted on the drafting board. But it is built in life, in the world of brick and stones, of mortgages and taxes, of rentals and vacancies.

Architecture is a practicing art, and a practical art. Its plans are carried to material completion in a hurly-burly of donkey engines and steam shovels, electric riveting machines, acetylene torches, plus a medley of sidewalk superintendents. Even in traditional American wooden frame houses, the ring of the handcraft carpenter's hammer sings of actiity, as does the wet swish of the handcraft house painter's brush.

Architecture is the most basic of the arts. Today, as at the dawn of history, it satisfies the need for physical protection and for psychological security. It feeds, also, the individual's hunger to be one of the human community. These aspirations, rooted in primitive man's early experience, express themselves differently today; nonetheless they root architecture in human feeling.

Contemporary architects call their vocation by new names. Present-day mass production industrial civilization has created a new art, they say. Some suggest shelter instead of the rhetorical greed work derived from "master-builder." Others prefer design correlation, design co-ordination or design synthesis to suggest the fact that the architect is a designer who integrates a variety of skills, techniques, bodies of knowledge, and methods of procedure.

Two great wars have accelerated, by scientific discoveries, the production of new materials. The automobile and airplane have altered our concepts of space and time. Aesthetic embellishment in the sense of applied ornament does not seem to fit the period in which we live. Mounting costs of materials and labor have limited the ability to build and increased the need for initiative and imagination in achieving economy. The practicing architect has had to re-evaluate his approach to design.

Architectural design was formerly based on an understanding and adaption of historic styles. Traditional materials used in uniform ways developed established procedures which helped to standardize building costs. Public buildings were often palatial, and a $25,000 house was a mansion. A five room house of today costing about $10,000 could have been built in the 1930s for $3,000 or less.

Architecture and engineering, like medicine and the law, tend to close their gates to women. One well-known university will not allow women to attend its day classes, only its evening classes! In 1940 only 2.3 per cent of 21,976 architects were women.

Architects were formerly trained in ateliers or studios. The formal curriculum for the architectural student is of recent origin. A half century ago architects were still taught in a master-apprentice relationship. If the master was a good architect, the system was well enough. In general, however, it fastened a Beaux-Arts tyranny on the American scene, as may be seen in the pseudo-classical structures that dot the native landscape.

Illinois has a license law for architects. To obtain this license you should have a degree of bachelor of architecture, or its equivalent, you must have served at least one year in the employment of a registered architect, and you must pass a written examination. As the present laws stand it is not necessary to have a degree in architecture, but one must spend at least ten years in apprenticeship to a master architect.

Specialization ultimately evolves out of mature experience, and successful practicing architects acknowledge this by their insistence on well rounded college training for the architectural student.

An ex-GI studying industrial engineering in 1949 was discovered by his wife one night standing over his baby's crib. Silently she watched him. As he stood looking down at the sleeping infant, she saw in his face a mixture of emotions that she had never seen before—rapture, admiration, doubt, despair, ecstasy, incredulity. Touched and wondering alike at his unusual parental attitude and the conflicting emotions, his wife, with eyes glistening, arose and slipped her arms around him. "A penny for your thoughts," she said in a tremulous voice.

He blurted them out: "For the life of me, I can't see how anybody can make a crib like that for three forty-nine."

Engineering Opportunities

by Fred L. Maytag II

Fred L. MAYTAG, II, president of The Maytag Company, Newton, Iowa, is the third generation head of the washing machine manufacturing company which bears his name. One of the country's leading manufacturers, Mr. Maytag is active in a wide range of business, industrial and public affairs. He is a member of the board of directors and chairman of the taxation committee of the National Association of Manufacturers, trustee of Grinnell College, Grinnell, Iowa, and a member of the board of governors of the Midwest Research Institute. A former Iowa State Senator, he has received numerous special recognitions for his accomplishments, including a ten-page picture layout in Life Magazine featuring his community activities. Mr. Maytag is an enthusiastic flyer and pilots his own plane on business and pleasure trips.

A casual glance at the classified advertisements in any of our metropolitan newspapers, today, makes it apparent immediately that there is a tremendous demand in industry for graduate engineers of all types.

This demand has grown to its present proportions because of two basic conditions: An insufficient supply of graduate engineers, and a tremendous increase in the number and types of industrial jobs requiring engineering graduates.

As industry, generally, has advanced, the complexities of its operation have increased markedly. As mass production techniques have been developed, the need for technical know-how has grown correspondingly. In the development of new products, and the improvement of existing products and processes, industry has found it necessary to depend more and more upon the engineer.

There was a time, not so long ago, when the engineer was required in industry primarily to direct the maintenance and research activities required by the employer. Long since, however, employers have been looking to engineers to fill an increasingly large percentage of positions concerned with the production function. Gradually, employers have begun to fill the vacancies in top management positions with engineers who, because of their technical training and experience, are able to comprehend the problems of production management, as well as those of the specialized staff functions.

For these reasons, there is almost no limit to the opportunities available to competent graduate engineers. I would add one word of caution, however, and that is this: Industry is more and more concerned in finding in its engineers, something more than mere technical competence, or even technical brilliance. Industry wants engineers who, in addition to their technical competence, have an adequate concept of historical and sociological aspects of the industrial function. Furthermore, industry wants in its engineers, a facility for maintaining satisfactory personnel relationships. Industry is concerned in employing engineers who are, first of all, good citizens in the broadest sense of the term; and who are, secondarily, good engineers.

The present employment opportunities for engineering graduates are undoubtedly the best in the history of our economy. Even the man who has narrowly specialized, at the expense of developing "the whole man," can almost write his own ticket—initially. Furthermore, he can feel reasonably assured that industry's need for his specialized skill will not diminish.

But the opportunity to rise higher in the ranks of management, to positions of broader responsibility, will increasingly be reserved to those engineers who combine a high degree of technical competence with a truly liberal education, superior ability to establish and maintain good interpersonal relationships, and marked capacity for continued personal growth.

Little Willie, He's a brat,
Broke an egg in Daddy's hat.
Then he laughed in fiendish glee,
When Poppa said, "The yolk's on me."

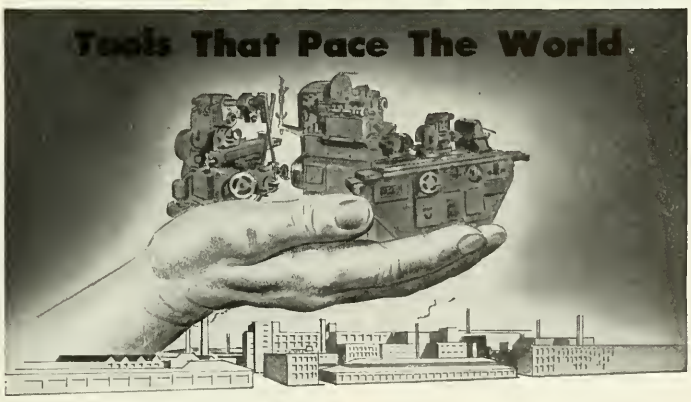
* * *

You haven't really proved
If you are a man or a mouse
Until you've spent a winter
With plumbing outside the house.

* * *

"Tell me, Duke," asked the solicitous American host as his French guest landed in New York, "what is the first thing you would like to see in the United States?"

"Zat ees easy," said the visitor. "First I weesh to meet ze amazing Madame Beech who had zo many sons fighting weeth ze Americain Army to save France in ze last war."



Mass production is the key to America's industrial development and every manufactured need can trace its beginning back to machine tools and precision measuring tools.

For over a century the Brown & Sharpe Mfg. Co., old in experience, young in ideas, has been working for the present but planning for the future; producing the machine tools and precision tools that set the pace for the nation's progress.

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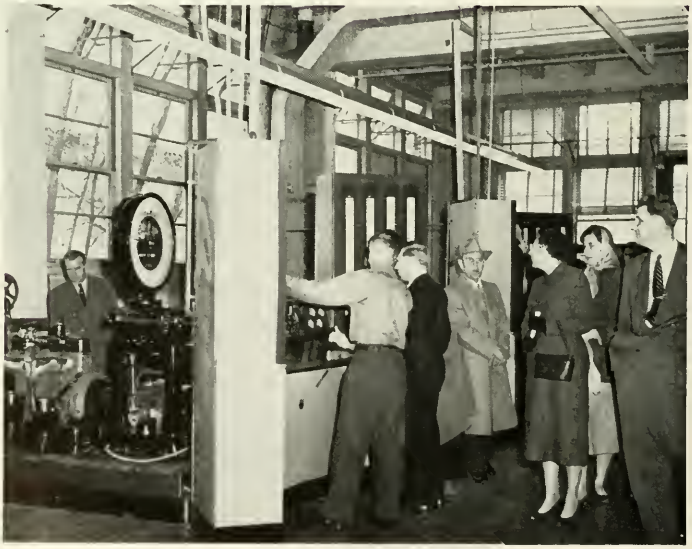
1954 ENGINEERING

The Physics Department's demonstration of static electricity. The physics students are shown giving a demonstration to an Open House audience. These exhibits won the first place for the best displays as judged by the high school students. Other physics displays were gyroscope, and inertia experiments, liquid nitrogen and air, Van de Graff generator, and cosmic ray telescope.

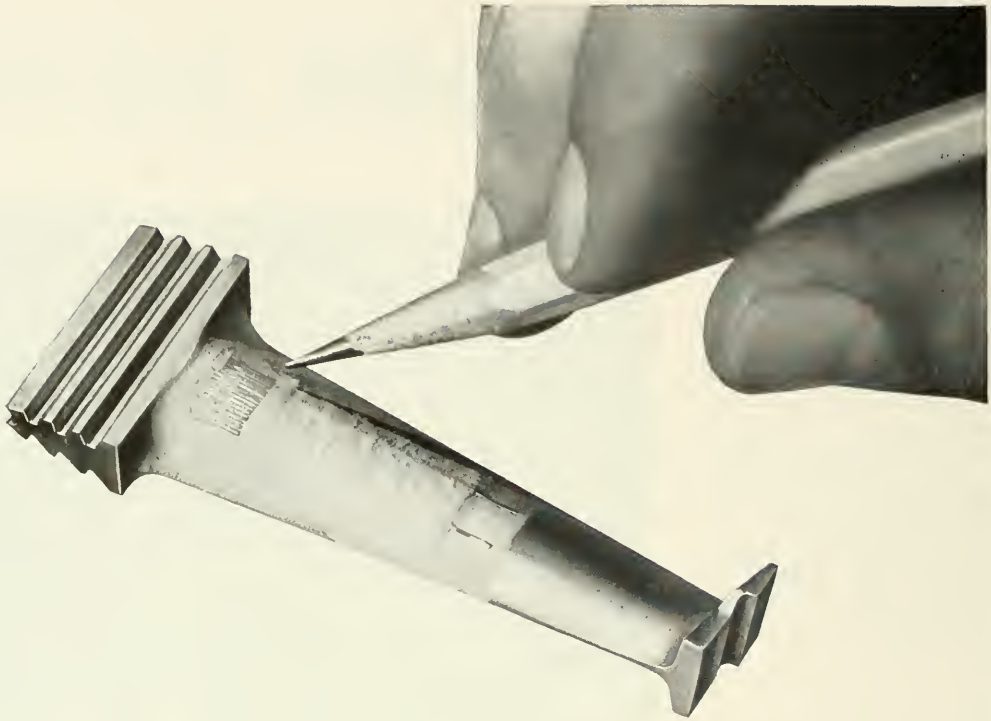
The Mechanical Engineering Department's Open House display of their internal combustion laboratory. Open House guests are watching the power and economy tests of the GMC engine in the internal combustion laboratory. This display tied for second place with the Electrical Engineers' display. Other Mechanical Engineering displays were steam engines, turbines, foundry, and reaction time and stopping distance testers.



OPEN HOUSE . . .

This pan is actually floating on air. The aluminum sauce pan is supported by electromagnetic waves generated under the table. The Electrical Engineering Department's exhibits tied for second place. Other exhibits by the Electrical Engineers were atomic cannon, electronic lecture, illumination lecture, "Kiss-O-Meter," and many other interesting things.

Wayne Barker, junior in Civil Engineering demonstrates stream flow through a culvert. Hydraulic studies on models such as this have resulted in improved drainage structures under highways and railroods. Continuing research has brought about changes in design specifications consistent with modern engineering theory.



important wire on a hot subject . . .

Even at temperatures of 1500° — speeds of 12,000 rpm — this tiny wire grid reports to our engineers on the strains in jet turbine blades. It gives them accurate measurements for calculating stresses caused by resonance and flutter.

This basic information, in turn, permits the design of blades that combine the optimum aerodynamic characteristics with structural integrity.

Strain gages are not new. But our engineers had to advance the art considerably to get readings at these high speeds and temperatures. It required the development of improved cements, instrumentation, slip rings . . . new application techniques and calibration curves.

Nothing can be left to chance in the design of aircraft engines for supersonic flight. Thus we use — and frequently improve on — every advanced technique and engineering tool. This straight-forward approach to engineering problems is one of the reasons many outstanding engineering graduates decide on a career at Pratt & Whitney Aircraft.

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logical way

—*to a promising future!*

A RECENT SURVEY shows that many of today's leading engineers and industrial executives walked through this door to start their careers.

In fact, the majority of all leading positions in automobile engineering are held by men whose basic training was in designing—one of the best paths for the young man who wants an engineering career.

And if you want to be an automotive engineer you can't find a better place to start than with Pontiac. Experienced engineers stand ready and anxious to help young men with fresh ideas tackle problems that when solved will mean still finer and more dependable cars. Here's a company you can grow with, a company that offers a future limited only by your own ability.

It's a very logical way to a career based on opportunity and advancement and liberal compensation plus General Motors employment benefits.

Pontiac's huge new engineering building is one of the industry's most modern—with every conceivable facility for designing better and better Pontiacs.

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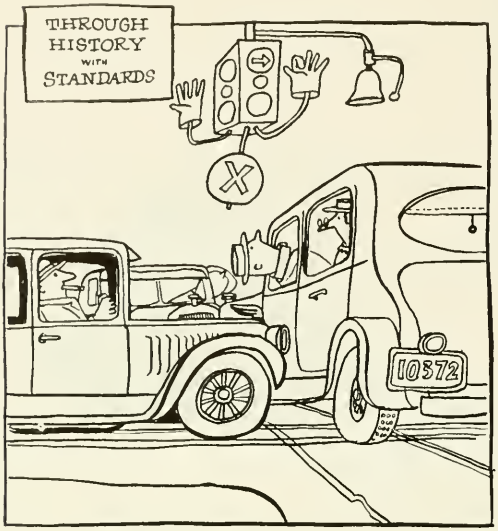
GENERAL MOTORS CORPORATION



The majority of men slip into their graves without having encountered on their way any signal catastrophe.

ALEXANDER SMITH, Dreamthorp

WHY TRAFFIC SIGNALS WERE A GREAT HAZARD BEFORE THEIR STANDARDIZATION

As late as 1927 a color-blind autoist stood as good a chance as anyone of interpreting traffic signals. For lack of national standardization, he could choose between purple, orange, blue, green, yellow, and red lights for his directions as he drove from state to state. Green, for instance, was "Stop" in some states and "Go" in others. Red, instead of yellow, was the caution signal in New York City.

And a motorist would have to stop his modern low-vision car a block back from the next traffic light in order to see it. Early signal towers often were as high as the second story on business buildings.

These problems have been solved in two national codes—one on colors for traffic signals, and the other on street signs, signals, and markings.

A national code for colors for traffic signals was first formed in 1927 through work of the American Association of State Highway Officials, the National Bureau of Standards, and the National Safety Council. It was approved as an American Standard. It recommended green for "Go" and red for "Stop," now virtually a world standard.

The national code for street traffic signs, signals, and markings was first started in 1927 as an American Standard under the American Engineering Council. In 1935 a joint committee of the American Association of State Highway Officials and the National Conference on Street and Highway Safety drew up a Manual on Uniform Traffic Control Devices based on the prior work of the ASA project. It was approved as an American Standard. A new edition of the manual was begun in 1944 and published in 1948, containing significant revisions to meet present-day traffic conditions. Its recommendations for height of signals and design and color of signs are almost universally followed in this country.

HOW A STANDARD FOR STEAM BOILERS BROUGHT NEW SAFETY TO AN OLD HAZARD

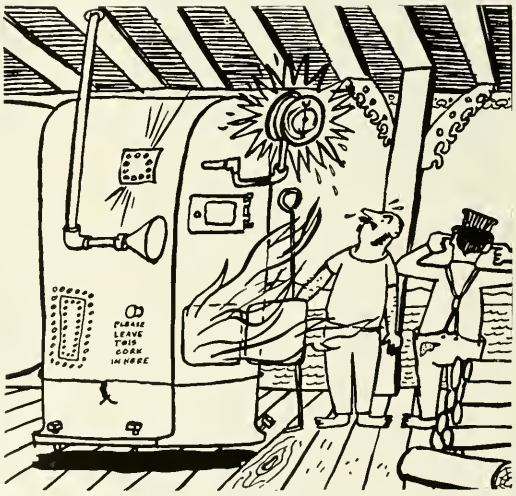
From the earliest practical applications of steam for prime movers in the 18th century, boiler explosions were a serious cause of loss of life and damage to property. Steamboat boiler explosions were especially common, comparing in frequency and severity with the worst catastrophies of today. On April 27, 1865, for instance, the steamboat Sultana, plying the Mississippi River near Memphis, exploded with the loss of 1450 lives.

In 1911 the Council of the American Society of Mechanical Engineers appointed a Committee to Formulate Standard Specifications for the Construction of Steam Boilers and Other Pressure Vessels and Their Care in Service (known since 1914 as the Boiler Code Committee). It issued the first ASME Boiler Code three years later.

The makers of this code set out to create a set of rules for the construction and care of steam boilers that would be adopted by all the states of the union. Today, 28 states and territories, eight provinces of Canada, Australia, Mexico City, and a number of other countries and cities have adopted one or more sections of the Code. Through its extensive use and uniform administration, the Code is now in every sense of the word a national standard.

The 1952 Code, as revised and enlarged, has nine sections totaling some 1,000 pages. It is administered by a committee of 24 members and an executive committee of eight, made up of men of special training and experience representing designers, fabricators, suppliers of materials, operators, and consultants. Some three dozen subcommittees serve under the Code committee.

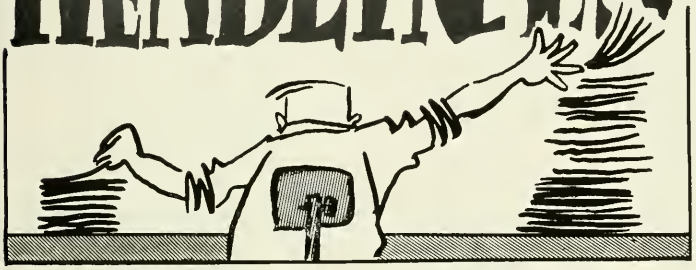
Since 1916 the record of serious boiler explosions has been exceptionally low, despite the great increase in the number and size of boilers. For this, the Boiler Code Committee has been in a large measure responsible. In a citation to the committee in September, 1952, the American Standards Association stated: "Probably no other single standard in America has done more for national safety than the ASME Boiler Code."



It shall be a vexation only to understand the report.

ISAIAH, XXVIII

SKIMMING INDUSTRIAL HEADLINES



edited by Larry Kiefling, M.E. '56

Better Photo Film

A remarkable new high speed professional sheet film—Kodak Royal Pan—is available in all sizes. The new film is twice as fast as previous films of this type. The increase in emulsion speed has been achieved, however, without any increase in film graininess.

The development, company officials indicated, represents a significant gain in film emulsion technology, since until the introduction of Kodak Royal Pan film emulsion technologists have been limited to their ability to achieve increases in film speed without accompanying increases in granularity.

The new film is expected to prove of tremendous value to press, commercial, portrait, illustrative, and industrial photographers. Its increased speed will be particularly helpful in these fields since it will permit photographers to make pictures which have heretofore been almost impossible.

The new film has an A. S. A. exposure index of 200 for daylight. The tungsten index is 160.

In addition to its speed the film has been designed to give improved shadow tone contrast or crispness. At the same time the company has been able to incorporate factors in the emulsion which reduce the tendency of highlights to "block up," as is often the case where overexposure or overdevelopment occur.

This reduced blocking characteristic is expected to be of particular help to photographers when the lighting range cannot be carefully controlled, since the resulting negatives can be printed with less shading and dodging. In such instances the greater transparency of the highlight areas also will be helpful in the production of better quality prints from difficult subjects.

This action shot was made on Kodak Royal Pan film at f-4.7, and 1 200th of a second.

By design the new film will tolerate a very wide range of both over and underexposure, and still produce negatives which will make satisfactory prints. To further complement the exposure latitude, the company has also increased the development latitude so that the contrast of the negative will not change as rapidly with small amounts of overdevelopment.

For example, a series of negatives exposed the same time and developed for 4, 5, and 6 minutes might very easily produce equally acceptable prints on the same grade of paper. Even a negative developed as much as 8 minutes requires only one grade of softer paper.

The increased speed of the film will in many instances permit pictures to be made with press type cameras which heretofore could only be made with reflex or miniature cameras having faster lenses. Pictures can also be made under conditions which would previously have been impossible for picture taking with professional sheet film cameras. On the other hand, the new film offers tremendous opportunities for improving the general run of photography because the lens stop can now be set one full stop smaller leading to increased depth of field or range of sharpness, or the shutter speed can be doubled to better stop subject movement.

Still other benefits offered by the new film is improved speed relate to its effectiveness with various types of lighting equipment.

The possibilities for the effective and convenient use of very small flash lamps —such as the No. 8's—are, for example, definitely improved. The faster film also makes portable speedlights the equivalent of being twice as bright, or, looking at it from another way, it opens possibilities for the building of even smaller, lighter weight, units.

Art: "Is your girl spoiled?"
Sam: "No, it's just the perfume she wears."

* * *

"I hear he was a big gun in college."
"That so? What kind?"
"A sort of smooth bore."

* * *

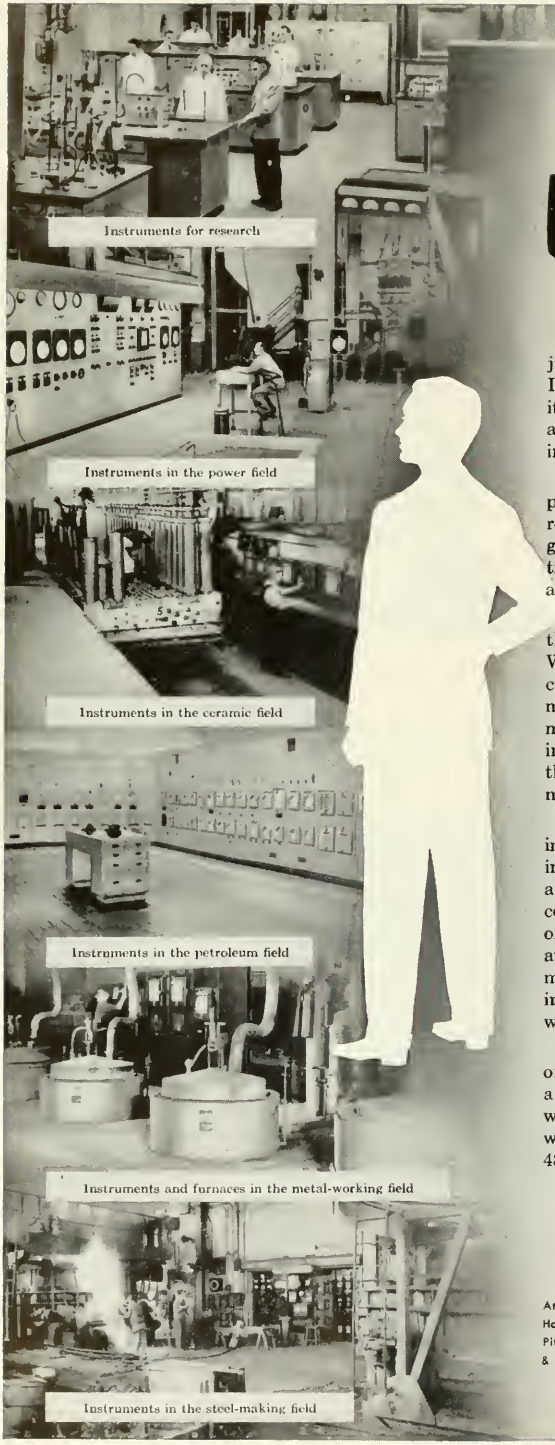
Ed Gardner's friend, Finnegan, was down at Duffy's Tavern enjoying a glass of beer. "How many barrels of beer do you use a day?" he asked the proprietor.

"Four," said the barkeep. "Why do you ask?"

"Cause I can tell you how you could use eight barrels a day."

"You can?" came the delighted response. "How can I?"

"Give full glasses," Finnegan retorted bitterly.


Instruments for research
Instruments in the power field
Instruments in the ceramic field
Instruments in the petroleum field
Instruments and furnaces in the metal-working field
Instruments in the steel-making field

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IN A FIELD WITH A FUTURE . . .

Instrumentation

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Here at Leeds & Northrup, we help to meet these demands for more and better instrumentation. We are a leading supplier of automatic, high precision, balance-type electrical instruments for many segments of industry. Our automatic and manual laboratory-type instruments for the worker in science and research are recognized throughout the world. In addition, we are among the leading makers of furnaces for heat treating.

Perhaps your opportunity is in our sales engineering division—helping to analyze and to solve the instrumentation problems of our customers. Or, as a market development engineer, you would be concerned with fitting L&N instruments to new groups of applications. Your interest may lie in the design and manufacturing of L&N products. If so, you may qualify for an opening in product engineering, industrial engineering, research, inspection or elsewhere among our 3000 people.

Decide now to investigate your place in the field of instrumentation. Ask your placement officer for a copy of our booklet, "Career Opportunities" which describes the highlights about L&N. Or, write to the Industrial Relations Department, 4850 Stenton Ave., Philadelphia 44, Pa.

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TH

ILLINOIS TECHNOGRAPH

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They Chew Their Way to Wealth. These teeth are capable of chewing through earth, sand and rock for thousands of feet until they reach Nature's buried treasures of gas and oil. Rock bits like this need super-strength, amazing toughness, high resistance to impact, abrasion, and shock. So, many of them are made from USS Alloy Steels. And United States Steel also provides many other essentials for oil drilling, such as wire lines, drill pipe, cement, drilling rigs.

Scoop! And a big one, too . . . it can scoop out 21.5 cubic yards of earth per minute. has a boom 215 feet long! The drag lines. boom support cables and hoisting ropes on a behemoth like this must have great strength, durability, flexibility, fatigue resistance. Tiger Brand Wire Ropes, made by U.S. Steel, meet all requirements.

A Man Needs a Cookie once in a while! And when cookies are kept in a tight cookie tin like this, they'll be fresh and appetizing for him. The can is steel, of course . . . made out of the same USS Tin Plate that is produced by U.S. Steel to make millions of "tin" cans every year for the protection of food, oil, paint and countless other things.

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Published eight times during the year (October, November, December, January, February, March, April and May) by the Illini Publishing Company. Entered as second class matter, October 30, 1920, at the post office at Urbana, Illinois, under the Act of March 3, 1879. Office 213 Engineering Hall, Urbana, Illinois. Subscriptions $1.50 per year. Single copy 25 cents. Reprint rights reserved by *The Illinois Technograph.* Publisher's Representative—Littell Murray-Barnhill, 605 North Michigan Avenue, Chicago 11, Ill. 101 Park Avenue, New York 17, New York.

THE ILLINOIS TECHNOGRAPH

volume 69 number 8

contents:

peacetime uses of atomic energy ---------- 9

fiberglas, a reinforced plastic ---------- 12

fairchild engraver ---------- 24

high vacuums ---------- 27

west point of the air ---------- 32

speed light ---------- 35

skimming industrial headlines ---------- 40

h. g. wells, dr. carl marvel ---------- 44

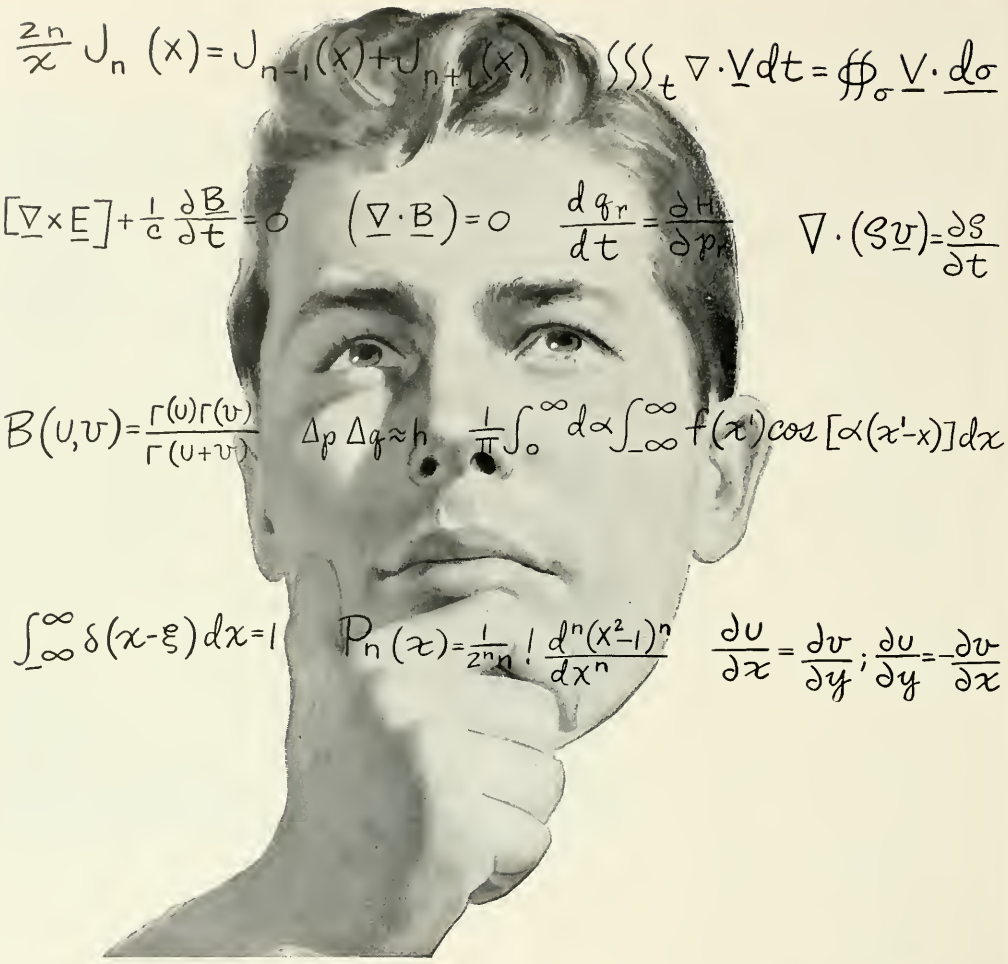
technocracks ---------- 48

our cover

It seems as though the more we hear about the development of atomic weapons, the more we hear also of research in peacetime uses of this tremendous power. Some of the uses shown here are already on the drawing board and will be realities in the very neor future. Dave Templeton drew the cover.

our frontispiece

A view of the Abbott Power Plant at the University of Illinois. The plant is one of the most modern in this state. It is equipped with dust collectors which nearly eliminates the soot nuisance. Three men per shift can operate and maintain the plant.


$\frac{2n}{x} J_n(x) = J_{n-1}(x) + J_{n+1}(x)$
$\iiint_t \nabla \cdot \underline{V} dt = \oint_\sigma \underline{V} \cdot d\underline{\sigma}$
$[\underline{\nabla} \times \underline{E}] + \frac{1}{c} \frac{\partial \underline{B}}{\partial t} = 0$
$(\underline{\nabla} \cdot \underline{B}) = 0$
$\frac{dq_r}{dt} = \frac{\partial H}{\partial p_r}$
$\nabla \cdot (\rho \underline{v}) = \frac{\partial \rho}{\partial t}$
$B(u,v) = \frac{\Gamma(u)\Gamma(v)}{\Gamma(u+v)}$
$\Delta p \, \Delta q \approx h$
$\frac{1}{\pi} \int_0^\infty d\alpha \int_{-\infty}^{\infty} f(x') \cos[\alpha(x'-x)] dx$
$\int_{-\infty}^{\infty} \delta(x-\xi) dx = 1$
$P_n(x) = \frac{1}{2^n n!} \frac{d^n (x^2-1)^n}{dx^n}$
$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}; \frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$

To a young engineer

. . . with his eye on the future

All your life you've been heading for this . . .

A place where ideas flourish, grow into realities.

A place where you're creating; contributing to human progress; using to the full your engineering education.

A place where what a man knows and what he can do are the things that determine his future.

Here at IBM, whether you're an ME, EE, or Engineering Physicist, whether your major interest is research, product design, or product development, there's something big for you to do, something that gives you not merely "job satisfaction," but job enthusiasm!

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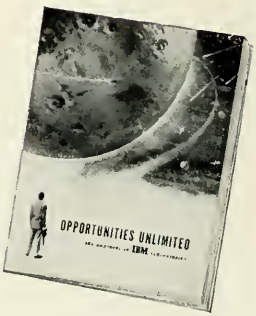

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PROGRESS AND SCIENCE GO HAND IN HAND

Our recently published annual report to stockholders tells more than the financial story of the progress of Standard Oil and its subsidiary companies in 1953. Its facts and figures also reflect the achievements of engineers and chemists.

For example, the report points out that:

More new and improved products were introduced by our company last year than in any other year since World War II.

Our scientists developed the Ultraforming process, a new and better catalytic reforming method for improving the quality of the straight-run portions of gasoline.

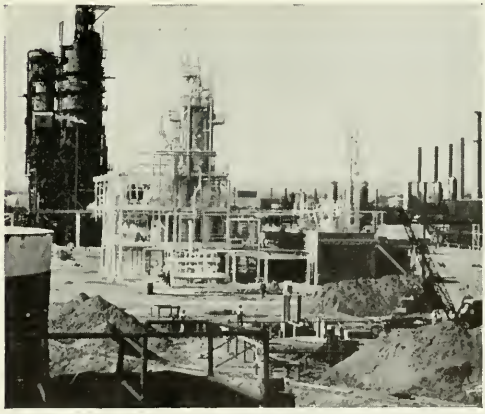
Three new research laboratories were completed.

More than $200 million was invested last year in new and improved facilities. (This year and next we expect to invest a total of about half a billion dollars.)

This continuing program of physical expansion and product development at Standard Oil provides many opportunities for engineers and chemists. Men with technical and scientific training have found great personal and professional satisfaction in our steady industrial advance.

Nearly a quarter of a billion dollars will be invested during 1954 and 1955 in development of new crude oil production and reserves.

Basic research on lubrication is one of the many activities at Standard Oil's extensive Whiting laboratories.



Almost a billion and a half dollars has been invested in expansion and improvement of facilities since 1945.

Standard Oil Company

910 South Michigan Avenue,
Chicago 80, Illinois

STANDARD

Peacetime Uses of . . .

ATOMIC ENERGY

by Alan England, E.Ph. '54, and Larry Kiefling, M.E. '56

A series of four lectures entitled "The Atom Outside of War" was given within the last month on the University of Illinois campus in Gregory Hall Auditorium. This series was sponsored by Sigma Xi research fraternity and was intended to replace the monthly lectures usually given by Sigma Xi. John C. McGregor, vice president of Sigma Xi, and H. O. Halvorson, president of Sigma Xi, originally planned the lecture series without a detailed outline of the subject material since the lectures were to give the latest developments in the field of atomic energy.

The lecture series was intended to promote interest in the monthly lectures which had been given in the past without regard to coherent theme or logic. The speakers chosen for this particular series were so selected because they were leaders in their rspective fields and could thus give the latest up-to-date information on this "hot subject."

The first lecture, given on February 22, was entitled "The Outlook for Industrial Nuclear Power." The speaker, Dr. Alvin M. Weinberg, is currently director of research at the Oak Ridge National Laboratory. Weinberg studied biophysics at the University of Chicago and during World War II helped develop the Hanford chain reactor. His present work deals with the topic of the lecture, the development of nuclear power.

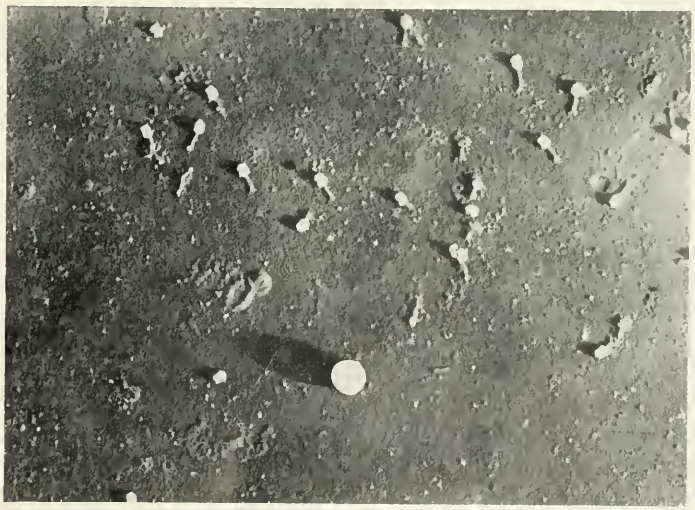
Dr. Weinberg mentioned that the first use of atomic energy industrially would probably be the utilization of small reactors for isolated, small scale projects as mines, air bases, military installations, and ships. The very fact that a reactor could be built for use in a submarine has already shown that the use of small reactors is feasible where the cost is not important. Large scale power plant reactors will, in all probability, first be used in areas where power costs are now high as, for example, in England, in some parts of South America, and in other places where supplies of fossil fuels are in short supply.

The reactors now in use exploit the inherent advantages of nuclear fuels: compactness, oxygen independence, low temperature operation, and regeneration. The very fact that a reactor can be made as small as necessary allows it to be used where size is important, as in airplanes and ships. However, there is a limit to the power output and efficiency of such reactors so that it appears that their use in automobiles is not feasible at this time. Large amounts of fuel will not be needed with such power plants, however periodic chemical treatment of the reactor "fuels" is necessary to remove waste products. Since the reactors can be operated at low temperatures for many operations, only small size heat exchangers will be necessary as a rule.

The most desirable characteristic of an atomic reactor is its ability to produce its own fuel. Fissionable U 235, in a process known as breeding, is produced from U 238 when subject to the radiations found in some reactors. U 238 is the material that fissions and thus produces the chain reaction that keeps the pile in operation.

Three desirable characteristics not inherent in reactors and which must be developed are cheapness, reliability, safty, and desirable fuel characteristics. Uranium is perhaps the most expensive ingredient in the reactor. Other materials which are able to withstand the radiations, the temperature, and the pressure found in such installations are also necessary in large quantities. The chemical techniques involved in separating the radioactive waste products are long, tedious, and expensive. Another item is the amount and type of shielding necessary to prevent the human operators from being over exposed to the intense radiation of the pile. Elaborate precautions must be taken to dispose of the radioactive waste products so that they will not endanger humans.

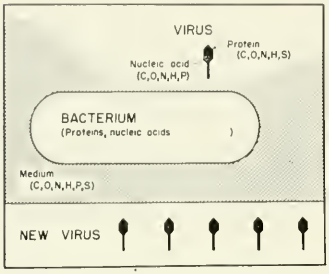
Since so many remote control operations are necessary, and since such extreme operating contditions are placed on the machines involved in these operations, the reactors, at the present time,



A slide used by Dr. Luria in his lecture. The "tagged" viruses are the small dots with tails. The large dot is a particle of known diameter used for measuring. The photograph is from an electron microscope.

are fairly unreliable. Future technological advances can be expected to solve this problem however.

Goodwill considerations abroad might well outweigh the benefits of domestic cost advantages that at first would be vanishingly small. However, as our supplies of oil and coal diminish, and as atomic power becomes more and more efficient nuclear power plants will become increasingly more advantageous to our domestic economy. Large scale central power plants will produce electricity for both a lower installation cost and a reduced operating cost, however, much work remains to be done in developing such plants.



The new viruses or the medium of the bacteria are "tagged" ond the virus shown at the top is checked for radiooctivity. This is another tracer technique.

The second lecture, given on March 1 by Salvador E. Luria, University professor of bacteriology and one of the nation's most noted scientists in his field, concerned the use of radioactive atoms in biological research. The two uses that were mentioned were in tracer techniques and in the determination of the age of fossils.

One tracer technique is to inject a radioactive substance into a parasite. The parasite is then allowed to enter a host where the parasite's locationand extent is determined by checking with a geiger counter where the radiations from the tracer in the parasite leave the body of the host with the greatest intensity. Another use of tracers might be in the study of photosynthesis. Plants require the gas carbon dioxide in order to produce food by photosynthensis. By surrounding an experimental plant with carbon dioxide containing radioactive carbon, the path of the sugar produced in this process can be traced with a counter. In such a tracer technique a small amount of the radioactive isotope to be used as a tracer is used with a large amount of the same element which is not radioactivity. A varying amount of radioactivity is thus made possible by controlling the consentration of the radioactive isotope. The isotope and inert element are chemically identical but not both radioactive. Both are treated the same way by the organism which absorbs them.

The second use of radioactive atoms is to determine the age of fossils and geological starata. Since it is fairly certain that the amount of radioactive carbon contained in the atmosphere has been held fairly constant over the last few million years, thus the amount absorbed by living things long ago should have been the same as is now absorbed by living things today. By measuring the decrease in activity of the radioactive carbon contained in old fossils compared to that contained in the bones of today, a good estimate can be made as to how old the fossils are. The radioactive carbon in the bones has a very long life expectancy and thus will remain in the bones for several hundred thousand years before entirely decaying and disappearing. This life expectancy is known quite accurately and thus the age may be determined quite accurately.

Rodger A. Harvey, head of the Radiology Department and acting dean of the College of Medicine presented the next lecture on March 8 concerning radioactivity in conjunction with medicine. Harvey joined the University staff in 1946, and in addition to his other titles, he is acting medical director of the Education and Research Hospitals in Chicago.

Dr. Harvey stated that radioactive materials are used in medicine as radiation sources and as tracers. Radiation sources are used for the treatment of such diseases as cancer and leukemia. Tracers are used extensively for research and diagnosis of disease.

Tracers, as mentioned before, are radioactive isotopes. The course of these tracers can be followed by measuring the radiation from them. Some elements pass quickly through the body while others tend to stay in the body and concentrate in certain places such as the bones and the liver.

Over one thousand radioactive isotopes have been produced and tried but only a few have been found useful. Many were rejected because they had a life time which were too short (sometimes a very small fraction of a second). Others give radiations too weak to penetrate the body tissues, some give off a very small amount of radiation—too little to do any good, others are toxic to the body, and others cannot be digested in the body.

Radium has long been used as a source of radiations for the treatment of cancer. Cobalt 60, which is less expensive is now being used with much success. Radioactive iodine is being used to treat cancer of the thyroid gland. The iodine concentrates in the thyroid gland and destroys any cancer cells in the gland. Radioactive phosphorous is used to help cure leukemia, a malady involving an excess of white blood cells. The phosphorus concentrates in the nucleus of the white blood cells and the radioactivity thus kills the cell.

The large amount of research which has already been conducted has separated the useless materials from the useful. This has taken tremendous amounts of time, money, effort because of the large number of isotopes which needed to be studied. As Dr. Harvey said concerning the problems yet to be solved, "The situation actually calls for an unlimited number of super-geniuses."

"Social Implications of the Atom Outside of War" was the title of the fourth and last lecture given on March 15. The speaker, Gordon Dean, former head of the Atomic Energy Commission, is well known for his book "Report on the Atom" published last year. Dean is currently employed by Lehman Brothers of New York.

Gordon Dean said before a packed auditorium that "social revolution will not result" from the use of the atom in peacetime. In addition he mentioned that he could not make any long range predictions about atomic energy and likened our present situation to the early days of electricity.

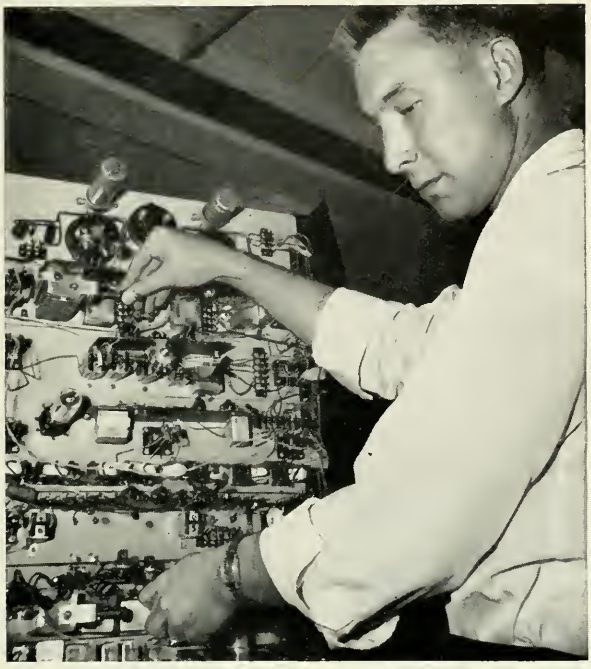
"Suppose we'd asked Ben Franklin ten years after he played with his kite about modern uses of electricity. What could he have told us about television and electronics?" Dean asked.

Dean conservatively predicted that peacetime uses of atoms would fit into patterns already established and further present trends. He doubted that atomic power would "make over the industrial face of a country." Only where conventionally made electricity costs too much or is unavailable will atomic power be economical. Underdeveloped areas like Brazil, or irrigation systems and mineral deposits in our own West which are far from other generating centers would benefit from atomic power.

Long established industrial areas might switch from coal to atomic power. Chicago and New York can get electricity from atomic reactors in the next ten years but costs would be about the same.

Large scale use of atomic power to free coal, gas, and oil for other uses should be emphasised, however the idea of small atomic power packages for automobiles should be deemphasized.

Dean was optimistic about radioactive isotopes in medicine, industry and agriculture. He said isotopes will play a big part in cancer research and treatment, although no spectacular cancer cure is yet in sight.



Bob Wilson uses a "breadboard" circuit, studying the electrical properties of a carrier system

"My first assignment at Bell Labs"

Fresh out of school, Bob Wilson, '53, was put to work on a Transistor project at Bell Laboratories. He explains why he never had time to be awed.

(*Reading time:* 39 seconds)

"In some ways it was hard to believe. I had received my B.E.E. at the University of Delaware in June, 1953, and a week later I was working in the world-famous Bell Laboratories.

"But I didn't have time to be awed because they put me right to work. They gave me responsibility fast.

"My group was working on the experimental application of transistors to carrier systems. My assignment was the electrical design of a variolosser for the compressor and for the expandor to be located in the terminals.

"The supervision I received and the equipment I had were tops. I quickly discovered that I had to rely on my ingenuity as much as on the college courses I had taken. Perhaps that's one reason for the great new discoveries continually turned out by the Labs.

"Now I'm in the Communication Development Training Program, continuing my technical education and learning what all the Laboratories sections do and how their work is integrated.

"In a year I'll be back working with the group with which I started."

• • •

Assuming responsibility fast is a common experience among the engineering, physical science, arts and social science, and business administration graduates who join the Bell System. Bob Wilson went with Bell Laboratories. There also are job opportunities with the operating telephone companies, Western Electric and Sandia Corporation.

BELL TELEPHONE SYSTEM

FIBERGLAS

. . . a reinforced plastic

by Norman E. Goelzer, M.E. '56

Fiberglas is a new material which is being used in many ways. This new engineering material called Fiberglas is being used more and more in the aircraft and electrical industries, but it is also used for items built by the home craftsman. Fiberglas products are formed in several different molding processes depending upon the type of part to be made and the number of parts to be produced.

There are two types of plastics: thermoplastic plastics (those which can be reshaped with heat) and thermosetting plastics (those which cannot be reshaped with heat). Fiberglas, as it is commonly called, belongs to the group of thermosetting reinforced plastics. The name, Fiberglas, is the trade name for the glass fabrics produced by the Owens-Corning Fiberglas Corporation, and it was given to the first reinforced plastics produced with glass reinforcement. Actually, the proper name for Fiberglas products is reinforced plastic laminates or plastic laminates, since Fiberglas is a series of layers of reinforcing material bonded together by a substance called resin.

A plastic laminate is comparable to reinforced concrete. The reinforcing agent in a Fiberglas product has the same function as the steel wire that is imbedded in concrete: they both carry tensile stress. The resin is also similar to concrete in that it is applied in the liquid state and then hardened to form the rigid product.

There are several groups of resins used to bond together the reinforcing agent. Each group contains one or more specific types. These resins are grouped according to their basic chemicals, and the types are classified according to the properties that they give to the final product. These groups are: phenolic, melamine, epoxy, silicone, and polyester. The polyester group contains the following types of resins: water-resistant, fire-resistant, flexible, rigid, high-viscosity, low-viscosity, quick-setting and slow-setting.

Impregnating the cloth with paint brushes. Care must be taken to avoid bubbles.

The phenolic group is used in the "high-pressure" process where quick setting and cure characteristics are needed. In addition to the phenolic group, the melamine, silicone, and epoxy groups are sometimes used in a high-pressure process. The high-pressure process is most generally used in mass production manufacturing because of the speed with which the product is made. This process uses metal molds which have pressures from 300 to 1,000 pounds per square inch applied by hydraulic presses. Pressure is needed because volatile gases are given off during the curing process forming bubbles that mar the surface if pressure is not applied to force them out. Heat is applied to speed the curing process. Phenolic resins are more adaptable to this type of process than the other types of high-pressure resins since no adverse effects of warping or cracking occur from the heat or pressure.

The resins of the polyester group are capable of being molded at low pressures or without pressure because no volatile gases are given off; therefore these resins are called low-pressure or contact resins. The heat necessary for curing these resins is produced by chemical reaction. Since the polyester resins require no heating and no pressure equipment, they are the ones most commonly used. In most cases, the type of polyester resin that is used for a certain job depends upon the object to be constructed and the method available for the construction. In other cases, determining the best type of resin to use is highly experimental since the field is still relatively new.

Since polyester resins are most commonly used, they are the most important group. This group of resins is produced from a by-product of the refining of

gasoline. Actually, the polyester resin is an alkyd-base resin, but it is frequently referred to as a polyester resin. The product from the refining of gasoline is reacted with a diabasic acid with dihydric alcohols. After the chemical reaction between the acid and the alcohol has taken place, the new product formed is co-polymerized with styrene or some other monomer in a heating process called "cooking." This cooking process, if continued long enough, will cause the resin to harden; therefore it is stopped at some intermediate time. This leaves the resin in a liquid form but with the ability to harden if heat is applied. The additional heat for the hardening of the resin is applied by the addition of chemicals which react to form the necessary heat. During this cooking process, the physical properties of the resin are greatly changed by the length of time it is cooked and by the addition of various chemicals. Phthalic acid is added to give the resin hardness; sebasic acid gives the property of flexibility to the resin; butyl alcohol and glyceral give the resin different degrees of viscosity. The chemicals added and the length of cooking time are determined by the specific job for which the resin will be used. For example, the following types of polyester resin are manufactured: water-resistant resin, fire-resistant resin, flexible resin, rigid resin, high-viscosity resin, low-viscosity resin, quick-setting resin, and slow-setting resin. Several types of resins may be blended together in various proportions to fit a certain job. Sometimes high-viscosity polyester resins and quick-setting polyester resins are combined for use on vertical surfaces where running characteristics are undesirable. For parts made of reinforced plastics that are subject to stresses or flexing, a flexible type polyester resin should be used to eliminate cracking. In other cases where flexing is not wanted, a rigid polyester resin is used. The only way to determine which resin to use is by experimentation as each piece or article to be constructed has its own requirements.

Since these manufactured products are formed from polyester resins in either the liquid form or powdered form, they are solidified in some way to form a rigid structure. Powdered resins are first dissolved in styrene to return them to liquid form for application. When resins are in the liquid form, they are solidified by the addition of chemicals. The chemicals added are called catalysts and promoters. They are mixed in the resins separately just before using, because once the chemicals have been added the resin soon passes into the "gel" stage where it can no longer be brushed on. The catalyst and promoter are never mixed together because they form an explosive mixture. The most common catalyst is methyl ethyl ketone peroxide (M.E.K.P.), and the most common promoter is a 6% solution of cobalt naphthenate. These chemicals react together to form the heat that changes the resin from the liquid state to the solid state. The two chemicals are added in very small amounts—1% by weight of catalyst and ½% by weight of promoter.

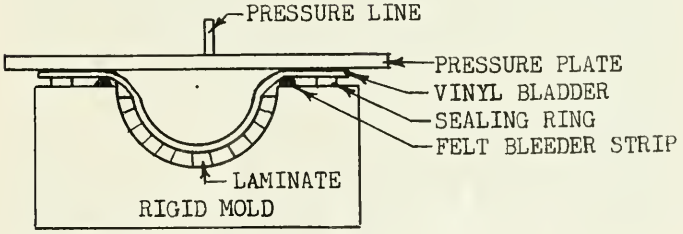
Female fiberglas mold reinforced with wood to produce Fibersport Car bodies.

Since such small amounts of chemicals are added, careful measurement of them is necessary to produce the desired gel time (the time necessary for the mixture to change from a liquid to a semi-solid.) Besides the heat formed by reaction of catalyst and promoter, heat from infrared heating lamps or other forms of heat help speed the curing of the resin. Another type of catalyst is used to cure the resin by reaction of it and sunlight. This type is called photo-sensitive catalyst. With this type of catalyst, the part must be set outside to cure. This has the advantage of allowing the entire fabrication of a very large piece, such as a car body or boat hull, before any curing takes place, but it also has the disadvantage of requiring a sunny day to be effective.

To give the reinforced plastic the finished color one of five methods is used. The first method is to add pigment to the resin. These pigments, varying from black to white, are organic, inorganic, or metal oxides. Another method is to place a colored sheet under the transparent surface of resin. Using this method, patterns can be introduced. The third method is to gel an over-laying colored film on the mold before fabrication begins. This colored film is on the outside of the manufactured product when it is removed from the mold. The fourth method of producing color is using colored reinforced fibers and a clear resin. The fifth method is applying a coat of paint to the finished product. Several of these methods can be combined to improve the color in the final piece. For example, a combination of pigment and painting gives the effect of depth, and it is the most popular method used today, especially on car bodies.

Together with the coloring agents, fillers are added to improve the laminated part. These fillers are finely ground clay, calcium carbonate, and aluminum silicate. The addition of fillers to the resin gives certain advantages over resins without fillers by improving the surface finish, reducing the cost, and improving other physical properties. The fillers improve the surface finish by reducing the shrinkage of the resin. This shrinkage leaves a pattern of the reinforcing agent used. Fillers also increase the viscosity of the resin which keeps it from running off the vertical sides of a mold and collecting in the low areas. Fillers also have disadvantages, such as increasing the weight and reducing the strength a small amount, but neither of these disadvantages are critical to the product.

Many materials are used to give



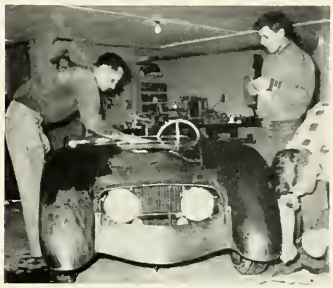
Bladder mold with laminate compressed by vinyl rubber blanket and air pressure.

strength to reinforced laminates, such as cotton, paper, asbestos, nylon, rayon, and glass fabrics. The type of reinforcing agent used depends upon the desired properties of the end product. Cotton is used where economical production is necessary; kraft and mitscherlich paper are used to impart high strength at low cost. Nylon is used to improve the non-conducting electrical properties, and asbestos is used in fire-resistant products. The most common reinforcing agent is some form of glass, either a woven cloth or a mat because it gives the best all-around properties of strength and resilience. Laminated pieces are made with one or more layers of mat placed between layers of cloth bonded together with resin. The method of lamination is called a "sandwich type" construction. Another method of lamination consists of using several layers of cloth as the reinforcing agent without any mat between the layers. This method gives pieces of less thickness and higher strength than those made with sandwich-type construction.

Woven cloth is manufactured from minute filaments of glass (.0002 to .0004 of an inch in diameter) which are spun into threads and then woven into cloth. The cloth is woven with different weaves for use in parts which require specific properties. Each of the five different weaves (taffeta, satin, louisine, leno, and twill) are classified according to the number of threads in the warp (fibers running lengthwise) and fill (fibers running crosswise). The number of threads in the warp and fill vary from 16 threads per inch in each to 100 threads per inch in the warp and 80 threads per inch in the fill. The difference between the number of threads in the fill and warp determines the directional strength. The ease of forming the cloth in a mold is also a factor dependent upon this warp and fill. A low number of threads in either allows the cloth to stretch and take the shape of the mold. This also helps to eliminate stresses in the part.

Mat is manufactured from the same minute glass filaments from which cloth is made. They are first spun into threads and then chopped into small pieces from 1 to 2 inches in length. These short lengths of threads are pressed into a thin mat which is held together by a resin binder.

The Owens - Corning Corporation uses two processes to manufacture the glass filaments: the continuous filament process and the staple fiber process. First,



Sanding the car body before the paint job.

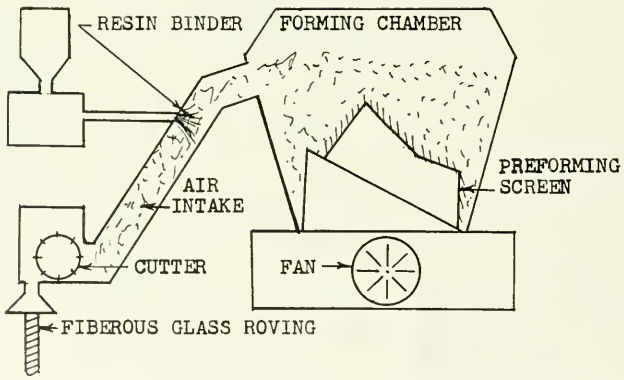
the glass is prepared according to specific formulas with a high degree of control and inspection; then it is formed into marbles which are 5/8 of an inch in diameter. These marbles are inspected for impurities before they are used to form the glass filaments. From each of these glass marbles, ninety-three miles of filaments are produced.

In a continuous filament process, the glass marbles are first melted in an electric furnace. Then the molten glass flows through small orifices, passes through a collector, and is gathered on a drum winder. Because the winder is turning faster than the flow of glass from the orifices and the glass is not completely hardened, the glass is drawn to a much finer size than that of the orifices. After being collected on the drum, it is processed into cloth or mat by textile machinery.

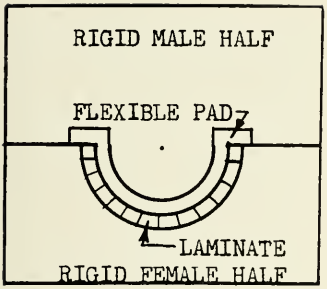
The other process is known as the staple fiber process. In this process, an air blast from small jets draws out the molten glass from the furnace through the orifices in filaments from 8 to 15 inches in length. The fibers pass through a spray lubricant and a drying flame and are blown downward by the air blast. These filaments are collected on a drum and combed into a sliver. These slivers are made into yarn by textile machinery.

In production of Fiberglas parts, various methods of fabrication are used depending upon the number of parts to be made, the rate of production, the size of the parts, and the shape of the parts. If the part is fairly small and has many compound curves which set up stresses in the part, a high-pressure method is used. This method, which produces parts which have smooth finishes on both sides and which have uniform thickness, consists of compressing the laminate between two matched metal molds. These molds must be easily constructed, easily machined, wear-resistant, and must have hard, dense, polished surfaces. The molds are made from aluminum, kirksite, mechanite, electro-formed copper, electro-formed nickel, and tool steel.

Preforming is the process of shaping the reinforced material (mat) into the shape of the mold before it is put in the mold and impregnated with resin. This preforming process is usually used in the high-pressure process but it could be used in other processes. It speeds the loading of the molds, eliminates hand tailoring of the mat, eliminates stressed areas in the mat if the part has complicated curves, and also eliminates overlaps and wrinkles. In this preforming process, pieces of chopped threads or roving are sucked by a suction fan through a spray of binding agent and on to a screen-wire frame shaped to fit the desired part. The desired thickness of the fibers of glass is controlled by the size of the holes in the screen-wire. In stressed areas, such as in corners, a thicker layer of fibers is needed; therefore the holes are made larger, allowing for more fibers to collect. Since the fibers gather on the wire frame in a loose fashion, they are held together by the binder agent that was sprayed on them as they were sucked on to the wire frame. This binder is not applied in sufficient amounts to saturate the resin but only enough to hold the fibers in place



Preforming machine—showing cutting and feeding of glass roving into an air stream which deposits it onto the preforming screen that has the contours of the part to be molded.



High-pressure mold with rubber pad between on half of the mold and the laminate.

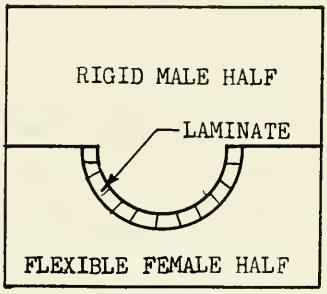
and the preform in shape. This small amount of resin does not affect the saturation of more resin when it is put in the mold and covered with resin.

The process of lay-up in the high-pressure process consists of placing the reinforcing material, either precut cloth and mat or preformed mat, in the mold and saturating the material by brushing, spraying, or injecting with phenolic or melamines resin. The other mold is placed in position and the whole assembly is placed in a hydraulic press where pressures of 150 to 1000 pounds a square inch are applied. If quicker gel time is necessary, heat is applied to the molds after they are in the presses. Cure time can be varied from 3 minutes to 30 minutes depending upon the temperature used.

A variation of this process is to use two metal molds similar to the ones used in the high-pressure process but with a vinyl rubber pad between one mold and the material of the laminate. This eliminates the need of accurate machining and polishing of the metal molds. In this process, the laminate is not as uniform in thickness as in the high-pressure process nor is the surface next to the rubber pad as smooth as the side next to the mold. Because the rubber pad is used in this process, lower pressures are used than in the high pressure process; therefore a polyester resin usually is used instead of the high-pressure resins.

A simpler method is used if the part is of simple design or too large to be easily handled in the two previous methods. This method consists of using only one rigid mold instead of two and one flexible mold made of vinyl rubber. The reinforcement is placed in the rigid mold which is made of the same material as the high-pressure molds. The reinforcement is saturated with a polyester resin, and the flexible mold is placed over it, compressing out all air and excess resin. Either the male or female mold is made the rigid mold depending upon which surface of the part is to be smooth. The surface next to the flexible mold is not as smooth as the one next to the rigid mold. This process is not as rapid as the high-pressure method.

The method requiring only one mold is the vacuum method. Since very low pressure is used in this process, the male mold or female mold can be made of a material which is not as strong as the high-pressure molds; therefore plaster or wood molds are usually used. The mat or cloth or combination of mat and



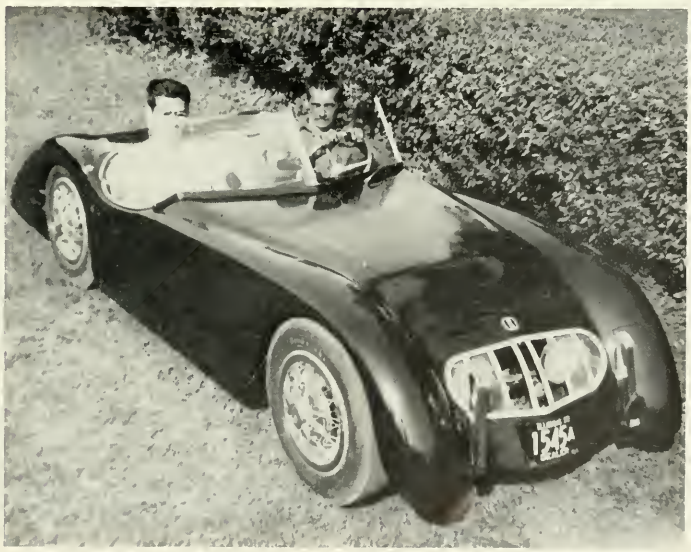
High-pressure of low pressure mold with laminate compressed between a rigid mold and o flexible mold.

cloth (sandwich construction) is placed over the mold and saturated with a polyester resin. Then a vinyl rubber blanket is put over the laminate and sealed around the edges; the air is evacuated through an outlet compressing the blanket on the laminate which squeezes out the trapped air and excess resin. This process can be used when only one side of the piece has to be smooth.

Sometimes shape of the part will require more pressure than is applied by the vacuum method and less pressure than is applied by the high-pressure method. If this is the case, a bladder method is used, incorporating a bladder and air pressure (15 to 20 pounds per square inch.) The method of fabrication is similar to that in the vacuum process, but instead of using a vacuum, the bladder is filled with air. This process requires a mold which is stronger than that used in the vacuum process; therefore the molds are sometimes made from metal or made from Fiberglas reinforced with metal.

The most common method of fabrication is the "hand layup" process. This method is used because of the small amount of equipment and experience necessary. This makes more economical construction and easier handling for the home craftsman. Because of the simplicity in using Fiberglas, it is used by the home craftsman for building boats, cars, and many other things. "It has been estimated that a plastic car body could be built with a pocket knife and and a paint brush." Although it is simpler than the other methods of fabrication, it is a time consuming process which is a disadvantage in mass production manufacturing.

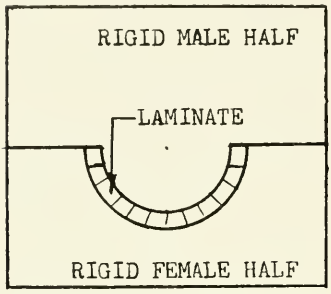
The best example of the hand lay-up process is the building of car bodies. Fiberglas allows the ordinary backyard mechanic to construct the car of his dreams which he could not construct from metal without a large amount of



Finished Fibersport cor produced by Fibersport, Inc., of Bloomington, Ill.

experience in working with mody metals. After the chassis has been decided upon, the preliminary drawing and a quarter scale model of the car are made. This will give the builder an idea of what the car will look like, and any changes that are desired are made before going on to the next step.

The next step is the construction of the full size male mold which is scaled from the quarter scale model. This mold



High-pressure mold with Fiberglas laminate compressed between the two halves of the mold by a hydraulic press.

is usually built on the chassis and consists of a wooden framework covered with screen-wire and plaster. If the chassis is not available for use during the construction of the male mold, careful measurements must be made so that everything will have the proper position and clearance. After the plaster has dried sufficiently, it is ground and sanded down until the true contours are obtained. The model is then painted with a dark, lacquer-base paint to seal the plaster and to show any defects in the surface. Since any defects that are visible will be transferred to the final body, they should be removed before starting the body.

The number of cars to be built and their required perfection determines what type of molding is necessary. For building the body of only one car, the body can be made over the male mold already constructed, but this requires a large amount of finishing on the outside of the body since the smooth side will be on the inside next to the mold. If only two or three cars are to be built, a female mold built from plaster and reinforced with burlap and metal is constructed and fastened together to form the whole mold. These sections of the female mold are molded from the male mold that has already been constructed. The female mold is made in sections to facilitate handling as a one-piece plaster mold is very heavy and hard to handle. A Fiberglas mold can be constructed if many bodies are to be produced. This is the most common procedure because the plaster molds, which are easily chipped or cracked, do not stand up well and require replacement after one or two uses.

After the female mold is finished, the lay-up process is started. First, the mold is covered with a parting agent, such as cellulose acetate, so the body will separate from the mold after it is cured. Cellulose acetate is applied in liquid form and covers the mold with a cellophane-like film when it dries. It is best to spray on the parting agent to assure a smooth surface. After the parting agent has dried, the mold is covered with several coats of wax and is polished. This is just further assurance of easy parting.

Now the first coat of catalyzed polyester resin is applied, usually with a brush, and allowed to harden. Allowing this first coat to harden is important if the female mold is used. If the first coat is not allowed to harden, the cloth will be squeezed out to the surface of the mold during the lay-up process, causing a weave pattern of the cloth to be visible in the finished product. This first coat is allowed to harden for several hours at least, but it is even better to allow it to harden over night. The next step is to brush on a light coat of resin and allow it to pass into the gel stage (until it is tacky to the touch) before applying the first layer of cloth. By applying the cloth when the resin is tacky, the cloth sticks to the mold but does not become saturated with resin. This keeps the hands from becoming sticky with resin and eases the lay-up procedure. Since the cloth does not become saturated, the next step is to cover the cloth with resin to saturate it completely. This process is continued until the body is the desired thickness. The thicker the body is made, the stronger and heavier it becomes. The lamination usually consists of either four or five layers of cloth, or a layer of cloth, a layer of mat, and another layer of cloth (sandwich type construction.) The first method gives a slightly stronger body than the sandwich type method, but it costs more.

After the lay-up process is completed, the body should remain in the mold for several days at least; a week is even better to allow the curing process to take place. This is necessary to eliminate warpage that occurs if the body is removed from the mold too soon. The warpage is caused by the final curing process of the resin. Even though the curing process looks as if it is complete in a day, the final curing takes about a week. During the period of waiting until the body is ready to remove from the mold, any reinforced braces and mountings are attached with a layer or two of cloth and resin.

After the body is removed from the mold, the flashing (the excess cloth and mat) around the edges, is removed with a saw. An electric hand saw accomplishes this job very well. Now the body is mounted on the chassis before painting so that it will not be scratched during the mounting operation. If only a male mold method is used, a lot of grinding, sanding, and filling is necessary to eliminate the joints caused by the overlapping of the pieces of cloth used in the body, but if the female mold method is used, only light sanding is necessary before the paint is applied. After the doors, trunk, and hood are fastened on, the body is about completed.

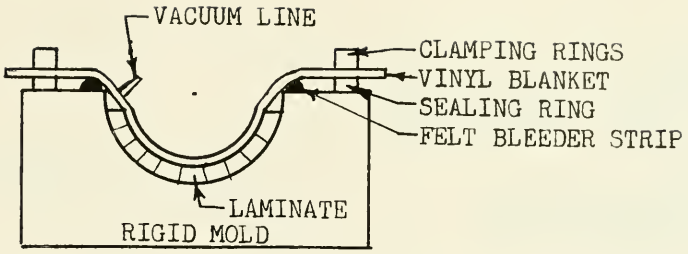
The manufacture of the Chevrolet sport car, the Corvette, whose body is constructed of Fiberglas, illustrates the

Applying the first coat of resin to the mold with paint brushes.

various molding methods. The body is composed of forty-one Fiberglas parts, of which seventeen are major parts. These forty-one parts require sixty-one molds and three molding methods. The larger parts, such as the major part of the body and the floor boards, are manufactured by the hand lay-up process; the small, simple parts are constructed by the vacuum method, and the complicated parts that have compound curves, such as the dash ,are constructed by the high-pressure method. The original molds for the car were made from mahogany, and although some of the mahogany molds are still used, the majority are constructed from Fiberglas. The finished body weighs four hundred pounds which is about 2/3 the weight of a similar steel body.

Although Fiberglas is still a new material, it is becoming more and more important to the industries in America and to the military forces of the United States. It is now being used extensively in the aircraft industries to replace many aluminum parts. The army uses it in the body armor being worn by our troops, and the navy uses it for small boats.

It is also used in the electrical industry because it has very good non-conducting properties. Fiberglas is not a serious threat for replacing metals because of the time-consuming and complicated lay-up procedures, but it will be used more and more as new and faster methods of manufacturing are discovered.



Vacuum mold with laminate compressed by vinyl rubber blanket and vacuum

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To be left alone
And face to face with my own crime, had been
Just retribution.

LONGFELLOW, *Masque of Pandora*

WHY A STANDARD BRICK BECAME COMPULSORY IN 17TH CENTURY BOSTON

A term in the stocks with a pile of out-size bricks to contemplate—that could have been the penalty of early builders back in 1689 when Boston was destroyed by fire. It was a civic crime for brickmakers to make bricks other than 9 in. x 4 in. x 4 in. size. City fathers recognized standardization as essential to the most economic and speedy rebuilding of the city.

Even 275 years ago the bricks were only one inch off the idea of the Modular Method which is now being rapidly advanced in the building industry. The activities of Project A62, organized by the American Standards Association in 1939, are spearheading this advance.

The Modular Method is the standardization of all building materials on a uniform basis of dimensioning. The architect figures everything that goes into a building on the basis of a standard module—multiples of four inches—in all directions.

Thus lumber, bricks, tile, concrete blocks, wallboard, flue linings, and framing fit in place without alteration and leave space for doors, windows, cabinets, and other pieces to slide into place.

The four-inch module was chosen because (1) it is large enough for manufacturers to reduce the number of stock sizes and still satisfy consumer demand; (2) it is small enough for ample freedom in architectural design and for flexibility in equipment layout; (3) it coincides with the dimensions of a great many building materials already standardized and is applicable to present construction practices; (4) it is a unit measurement with which architects, builders, and carpenters already are familiar; (5) it approximates 10 centimeters (3.9 inches), the basis proposed by metric system countries working on the same problem.

The module means the elimination of many odd sizes and thus permits smaller inventory for the manufacturer. It means smaller inventories and speedier service for dealers. It permits architects to spend less time in drafting and more time on improved design. Easier estimating, more efficient methods on the job, less construction time are possible for the contractor. When the modular method is used, everything fits. There is no needless, wasteful hand-cutting at the building site .

The Fairchild Engraver

by Don F. Kesler
E.E. '56

We at the *Technograph* have to wait about five or six days to get our picture cuts from the engraver. To a newspaper, printing the news that late would be suicide. How do they get their pictures in the paper a few hours after an incident happens?

Most newspaper and magazine pictures are halftones. A halftone viewed under a microscope will look like a series of dots lined up in a row. Some of the dots will be larger than others. In particular where the picture is light, the dots are small, but where the picture is dark, the dots are large. The large dots transfer a large area of ink to the picture, while the small ones transfer less, thus part of the picture is darker than the other. In the regular zinc halftones the reflection of a photographic chemical on the zinc and immersing in an acid makes the low and high spots on the plate.

The Fairchild Scan-a-graver is a device designed to electronically produce halftone engravings on a plastic material. This is done without photography or acids. It operates on the principle of shining a light on the picture and the reflection being projected in a photoelectric cell. The current from the cell is amplified to a sufficient power to vibrate a hot "needle."

The photograph is taped to the outside of a small cylinder and it is rotated at the rate of 33 1/3 RPM. The scanner is geared to cover the whole photograph at a slow rate. Each revolution is one eighty-fifth of an inch farther toward the end of the picture than the previous one. The rows of dots are spaced eighty-five to the inch.

The scanner is a device containing a light focused at a small point on the picture, and a lense picking up the small square of the light. The light is directed into a photo electric cell. The dots are formed because the light is caused to flicker at the rate of 305 times a second by a modulating generator. Out of the photoelectric cell comes an electric current corresponding to light or dark space the light was shined upon. This signal is amplified and sent to the receiver, at the other end of this scan-a-graver.

The receiver consists of an identical cylinder, rotating at 33 1/3 RPM, and an instrument similar to the scanner. A sheet of non-inflammable plastic is placed on the cylinder to be engraved. The stylus is a steel shaft approximately 3/4 inch long and of 3/32 inch diameter, possessing a 75 degree pyramid point. Around this is a coil of heater wire to heat the stilus. The hot stilus will burn a hole in the plastic if it touches it. A vibrater is set up so that the magnitude of the vibrations is controlled by the current from the photo cell. If a spot on the photograph is white, the photo cell is activated by the reflected light and it is sent to the receiver and the signal causes a maximum vibration and the stilus burns a hole in the plastic. After you start the cylinders rotating, the engraving will be completed in about six minutes, depending upon the size of the picture.

The scan-a-graver was especially designed to be used for all types of pictures regardless of whether they are the right contrast or not. The amplifier controls the contrast of the picture. There are separate controls to set the light in the picture as well as the dark. The scan-a-graver is set at the lightest spot in the picture to give the maximum amplitude of vibrations of the stilus. This burns out most of the surface of the plastic engraving material leaving very little surface for the ink to print the paper. The darkest spot is set to give very little vibration of the stilus. The intermediate shades in the picture are stretched out between white and black regardless of whether the original was very contrasty or contained little contrast.

These engravings are equally adaptable for either flat bed or rotary presses. The paper may be made up and the picture put in just before press time. In rotary presses, a block .895 inches high is put in the place of the cut and the mat is rolled. The mat is then put in the casting box and cast in lead. After the stereotype is shaved, the adhesive is stripped back and fastened in place. In flat bed printing the adhesive backed scan-a-graving is attached directly to a .895 inch base in the form. This base plus .003 inch for the double coated tape and .020 inch for the scan-a-plate raises the engraving to the .918 inch height of the surrounding type.

You have had the paper several days by the time we get the cuts of the same pictures for the *Technograph* you saw in the paper. Thanks to the Fairchild engraver we get the news just after it happens.

Frank Slepicka is setting the stylus on a Fairchild Engraver

Daughter had been invited to her first formal dance. She pleaded for a strapless gown, but mother wouldn't hear of it.

After arguing bitterly, they put the problem up to father.

"Let her try it on," advised Dad. "If it doesn't fall down she's old enough to wear it."

A Lot of Nothing . . .

HIGH VACUUMS

by Harvey Endler, E. Phy. '56

At the beginning of the twentieth century the science of vacuum production was still in its infancy. This extremely slow growth of a process which had had its discovery many centuries earlier was due mainly to the fact that up until that time vacuums had no industrial applications—they were merely phenomena to be toyed with and speculated upon by physicists in their laboratories. For the purposes of these men, piston-operated pumps, such as had first been used by Otto von Guericke in 1654 in his famous Magdeburg hemisphere experiment (two teams of horses were unable to pull apart two evacuated hemispheres held together by atmospheric pressure) were sufficient.

Now, however, vacuums are no longer laboratory novelties. They are mainstays to such diversified industrial processes as the distillation of penicillin and the production of cathode-ray tubes, and their scope of usage is constantly increasing. The importance of vacuums in innumerable industrial and research applications cannot be overemphasized.

It is to be understood that the term vacuum is only relative; the most highly evacuated chambers which man can produce contain hundreds of millions of molecules per cubic centimeter. The term high vacuum is arbitrarily applied to vacuums in which the pressure is one micron (one micron is equivalent to a pressure of 10^{-3} mm of mercury) or lower. The best vacuums which can be produced today range down to pressures of 10^{-8} mm of mercury.

These low pressures are achieved mainly through three devices—the rotary mechanical pump, the diffusion pump, and the molecular pump, the first satisfactory models of which can be attributed to a German professor, W. Gaede. In any actual high vacuum system these pumps are not used individually but are usually arranged with several pumps (not necessarily the same types) in series, so that the outlet of each pump is connected to the intake of the succeeding one, which is called a "fore-pump" or "backing pump" with the final pump delivering into the atmosphere. Thus if the exhaust of a pump is delivered into a region of low pressure rather than directly into the atmosphere, there is evidently less of a tendency for molecules to leak back into the system, and greater efficiency is achieved.

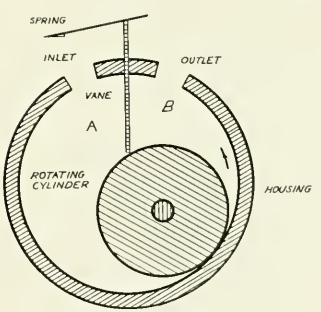
The rotary pump has three basic elements—an eccentric cylinder revolving in a housing, an oscillating vane that divides the inlet from the outlet, and a spring which keeps the vane tightly pressed against teh cylinder. Each cycle, the quantity of gas in region B (see figure) is pushed out of the pump, while a new volume A is formed entrapping more gas for compression during the following cycle. Mechanical pumps of this type are run in a bath of oil to seal and lubricate the sliding surfaces. Oil fills the space between the cylinder and housing and insures very little residual gas left in chamber B after compression has taken place.

These mechanical pumps can produce only a certain degree of evacuation before they lose their effectiveness, and are used mainly as fore-pumps in a system containing a molecular or a diffusion pump. This blank-off (final degree of evacuation obtainable) can be attributed mainly to production imprecision and operational wear permitting some back leakage into the evacuated chamber, effect on the vacuum of the vapor pressure of the oil and contaminants therein, and the solubility of the gas being pumped in the oil. Properties of oils are being carefully investigated to find which best serve the purpose of vacuum pumps. In general, the oil should:

1. Have low vapor pressure
2. Not deteriorate easily
3. Not react with the gas being pumped
4. Not be excessively viscuous at the temperature range of the pump
5. Have a minimum tendency to emulsify with any liquid present

Mechanical pumps cannot be used for pumping condensible vapors such as water vapor, oil vapor, etc. If a vapor such as water at 20 degrees C (vapor pressure of 20,000 microns) should enter the inlet chamber, it would volatilize producing a pressure of 20,000 microns and thus prevent any additional gas from flowing into that chamber. During the next part of the cycle the water vapor would be forced into the outlet chamber where the pressure would cause it to condense, resulting in a great decrease of volume with little or no flow through the outlet valve. Thus a reversible cycle is set up and little net pumping is accomplished. For this reason, drying agents such as phosphorus pentoxide or anhydrous calcium chloride, are placed at suitable points in a vacuum system to absorb any water vapor before it has a chance to enter the mechanical pump. Diffusion and molecular pumps are able to cope with condensible vapors since neither utilizes any type of a compression operation.

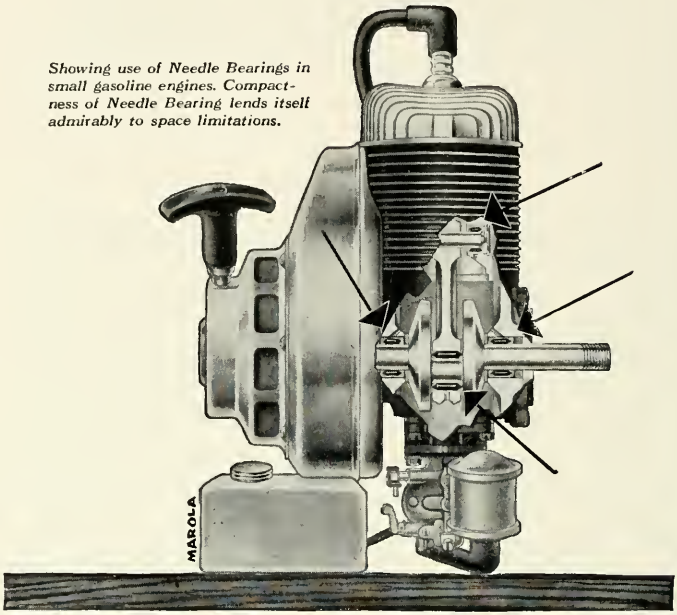
The diffusion pump was invented by Gaede in 1915. It is an efficient pump, capable of producing extremely high vacuums while maintaining large capacity. (Capacity, or speed of a pump, is the volume displaced per unit time.) Nevertheless, it is fairly simple in principle, consisting essentially of a boiler, a refrigerating unit, and a system of tubing. Oil, mercury, or some other suitable substance is vaporized in the boiler and the vapor is conducted through the tubing until it emerges at a high velocity in a downward direction. Molecules of the gas being evacuated drift into the high velocity vapor stream and are deflected downward along with the vapor into the refrigerated region where the vapor condenses and is recirculated back to the boiler. The gas molecules are easily removed from the refrigerated region by means of a fore-pump.



The rotary pump has only three moving parts—an eccentric cylinder, an oscillating vane, and a spring.

Diffusion pumps are usually built so

Torrington Needle Bearings save weight and space in many designs



Showing use of Needle Bearings in small gasoline engines. Compactness of Needle Bearing lends itself admirably to space limitations.

Because of its unique construction—a full complement of small diameter rollers retained in a one-piece thin drawn outer shell—the Torrington Needle Bearing has a small cross section. This makes it extremely useful in bearing applications where space and weight are at a premium.

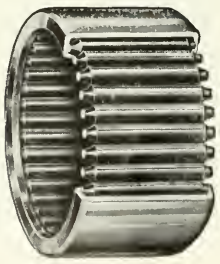
For a given load capacity, the Needle Bearing is the smallest and most compact anti-friction bearing available, giving the designer many opportunities to reduce the size and weight of surrounding members without lowering performance.

Smaller, lighter products

In an application like the small gasoline engine illustrated, Needle Bearings help keep overall size and weight to a minimum. Housings can be made smaller and lighter without sacrificing shaft stiffness and strength. What's more, the Needle Bearing's low coefficient of starting and running friction plus its ability to retain lubricants results in increased power output.

Simpler designs

Since a press fit in a simple straight housing bore is all that is required to locate a Needle Bearing, the use of complex retaining shoulders or rings is unnecessary. And, since the Needle Bearing usually runs directly on a hardened shaft—without an inner race – additional savings in space and weight are gained.



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that several vapor jets operate at the same time, each jet serving the purpose of a fore-pump for the one below it. This increases the probability of a gas molecule's being entrapped in the vapor stream. It has been calculated by means of the kinetic theory that the probability of a molecule's not being conducted along by the vapor stream is about 1 in 10^{20}, thus accounting for the high efficiency of diffusion pumps. As with the rotary pump, there is an ultimate vacuum which can be produced with a diffusion pump. This is determined mainly by the amount of air which the oil picks up while recirculating through the system and which escapes from the oil into the vacuum chamber.

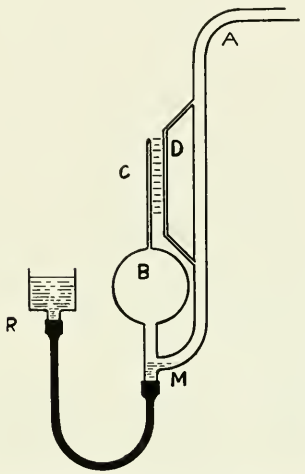
To prevent molecules of the mercury or oil vapor from entering the vessel being evacuated, diffusion pumps are provided with freezing traps at suitable places in the pump. These are usually vellels of liquid carbon dioxide mixed with either (temperature —78 degrees C) or liquid air (temperature —187 degrees C) upon which the vapor condenses. Although necessary, these freezing traps are a hinderance because they form an obstruction to the flow off gases which is very noticeable at low pressures.

Low pressures bring about many changes in the behavior of a gas. One of these is the lengthening of the mean free path of the gas molecules. The mean free path of a gas at any temperature or pressure is the average distance which a molecule of gas travels before colliding with another molecule. For example, oxygen at standard conditions of pressure and temperature (1 atmosphere, 0 degrees C) has a mean free path of 10^{-5} cm, whereas at a pressure of .000076 mm of mercury, its mean free path is a meter. The molecular vacuum pump (invented by Gaede in 1912) is dependent upon this characteristic of gases.

One type of molecular pump consists chiefly of a rapidly rotating cylinder in a hermetically sealed casing, with two inlet ports, one connected to the vessel being evacutated and the other to a fore-pump. After the pressure has been sufficiently lowered by the fore-pump for the molecular pump to take effect, the cylinder is set into extremely rapid angular rotation. Due to the low pressure, gas molecules which enter the pump have a much longer mean free path than the distance between the rotating cylinder and the casing of the pump, causing many more collisions between the molecules and the walls of the pump than between like molecules. Under these conditions the molecules tend to take up the direction of motion of the surface they strike—the rotating cylinder—and are carried along by its dragging action into the fore-vacuum chamber where they are removed. The kinetic theory gives the difference in pressure between the two ports as being

$$P_1 - P_2 = \frac{6Lwn}{d^2}$$

where P_1 is the fore-vacuum pressure, P_2 is the high vacuum pressure, L is the length of the slot between high and low-vacuum connections, n is the viscosity of the gas, w is the angular velocity of the cylinder, and d is the depth of the opening between the rotor and the pump wall. As the pressure in the fore-vacuum becomes very low, the difference in pressure between the two ports becomes independent of the fore-vacuum pressure, and becomes proportional only to the speed of rotation of the cylinder.



The McLeod gauge is an application of Boyle's law.

Accurate, fast, and dependable measurement of high vacuums is obviously of extreme importance. Varied and complex scientific principles underlie the use of many vacuum gauges, but the McLeod gauge involves merely an application of Boyle's Law. The McLeod gauge, named after its inventor, consists of an adjustable mercury reservoir R, a chamber B, and two equal-bore capillary tubes, C and D. The volume of the chamber and the cross-sectional area of the capillaries must be accurately known. The gauge is connected to the vessel being evacuated by means of tube A. By raising the mercury past point M, a known volume of gas is entrapped in B and C. The mercury level is then raised again until it reaches a height in tube D equal to the height of the capillary C. A reading is then taken of the difference in heights of the mercury levels in the two capillary tubes, rather than between capillary tube C and tube A; this comparison of equal-bore tubes eliminates errors due to capillarity. Application of Boyle's Law gives the pressure of the gas in mm of mercury as

$$P = \frac{a\,h^2}{v}$$

where V is the original volume of the sample, a is the cross sectional area of the capillaries, and h is the difference in height of the two mercury levels.

The McLeod gauge is the most widely used vacuum gauge because it gives accurate (down to 10^{-6} mm mercury) absolute pressure in simple direct readings. In fact, most of the other gauges are calibrated from McLeod gauges. Its disadvantages are that it cannot be used on easily liquifiable vapors and that due to the lengths of fine tubing involved, a full minute is sometimes required for the vacuum system and gauge pressures to equalize so that a reading can be taken.

The Pirani gauge operates on the more complex principle that for low pressures the thermal conductivity of a gas is directly proportional to the pressure. The Pirani gauge combines this effect with the fact that the electrical resistance of a conductor increases with a rise in temperature. The gauge consists of an electrically heated filament which serves as a variable resistance in a Wheatstone bridge arrangement. As the pressure in the chamber is lowered, the rate of heat transfer from the filament is decreased, and the change in resistance of the filament can be measured as the voltage is kept constant. An alternate method of operation is to keep the temperature of the filament constant, thus keeping its resistance constant, and measure the change in voltage as the pressure is altered. Absolute pressures of condensible vapors can be recorded on the Pirani gauge. The main drawback to its use is that the rate of heat transfer varies for each gas, and for accurate results the gauge must be calibrated for each individual gas.

The third main group of manometers consists of the ionization gauges. They consist basically of an electrically heated filament which emits a stream of electrons. The stream of electrons, in passing to a collecting electrode, ionizes the residual gas molecules which are then collected on a third electrode. For low pressures, the ionization current varies with pressure in the gauge and depends also upon the electron structure of the gas molecules being tested. The lowest pressures yet produced have been measured on ionization gauges.

Another vital phase of high vacuum production is the removal of residual gases which cling to the surfaces and are absorbed in the bulk of all materials, and which are constantly escaping from the material at a rate which is proportional to the temperature. Before any

vacuum system is put into operation, all parts are strongly heated to drive out these occluded gases. Metal parts are sometimes baked in an atmosphere of hydrogen which displaces the gases in the metal and which is very easily given off during later heating. Heating is often carried on during the whole period of exhaustion, and in late periods of evacuation high frequency currents are used to free the last of the residual gases. In a vacuum tube or other such device which is evacuated and then sealed off from the pump, it is extremely important that a high percentage of residual gases be removed during the evacuation period. Gases emitted by the glass walls and internal parts of the vacuum tube are considerably detrimental to the long life of the tube. A method for the removal of residual gases is the use of "getters." Getters are substances which are volatilized inside the cathode ray tube, radio tube, light bulb, etc., after the lowest pressure obtainable by the pump is arrived at, and just before the tube is sealed off. The getters combine chemically with residual gases and from compounds which are harmlessly deposited on walls of the vessel. Some materials (especially barium) continue to act as getters long after the tube has been sealed off. The alkali and alkali earth elements are best suited for this purpose.

Due to its transparency, non-porousness, heat-resistant qualities, strength, and ease with which it may be formed into various shapes, glass is the most popular material for use in vacuum systems. However, when large surfaces are involved, glass is sometimes not strong enough to withstand the atmospheric pressure and metal contructions must be used. The metal chosen must be non-porous, easily worked, relatively inert, and must be capable of strong union with the material adjacent to it in the system. Porosity of material is no longer so vital a consideration as in former times because waxes, shellacs, gums, oils, and cements have been especially manufactured for use in vacuum work, and a coating of one of these may be used to provide an excellent seal.

"If a drunk is Souse of the Border in Mexico, what is he in France?"

"Plaster of Paris."

* * *

A sign in front of a shoe repair shop pictured several styles of rubber heels and a beautiful girl who was saying, "I'm in love with America's No. 1 heel." Underneath in small feminine handwriting someone had added, "Too bad sister, I married him."

Rumor has it that one of our illustrious E. E. professors is writing a new text on DC machinery. It deals primarily with hot circuits and is entitled *Forever Ampere.*

* * *

The young grad should not try to impress his fellow workers with the extent of his knowledge. The truth will leak out soon enough.

* * *

"Do you believe in clubs for women?"

"Yes, if kindness fails."

* * *

A canny Scot was engaged in an argument with the conductor as to whether the fare was to be five or ten cents. Finally the disgusted conductor picked up the Scot's suitcase and tossed it off the train just as they were crossing a long bridge. It landed with a mighty splash.

"Hoot mon," screamed the Scot. "First you try to rob me and now you've drowned my little boy!"

* * *

Friend: "What is your son going to be when he passes his final exam?"

Father: "An old man."

POWER COSTS ARE WAY DOWN HERE

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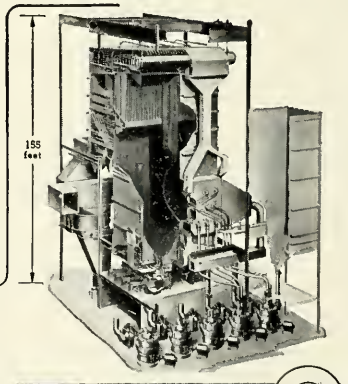

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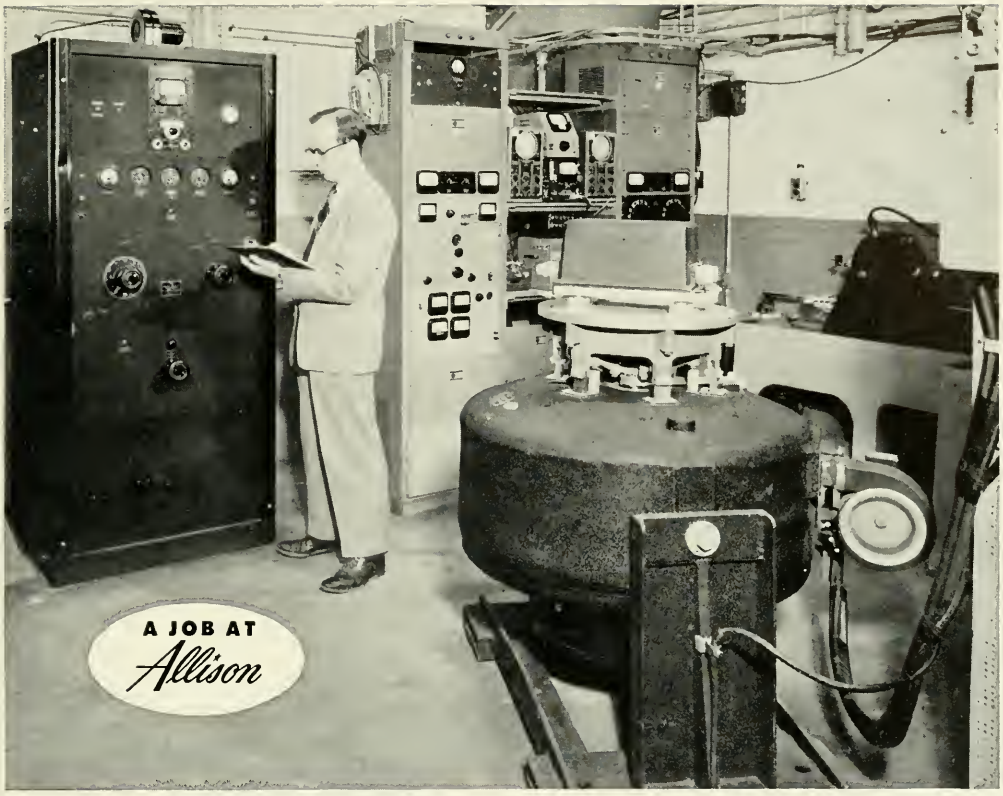

● Cort Kegley received his Masters Degree in Physics from Connecticut Wesleyan in 1951.

When the above picture was taken he had been on the job less than a month, and was one of a group of young graduates then in training at Allison.

Much of the experimental and test equipment at Allison is entirely different from any other. And, Cort—like other new engineers on the job—must first learn about these various facilities which he will be using in instrumentation and testing.

He is pictured here getting acquainted, so to speak, with some of the equipment used in vibration and shock qualification testing. One of the many electronic accessory units used with the Allison jet engines is here undergoing a "shake test" on the large MB vibration exciter shown in the foreground.

A turbo-propeller governor is bolted to the shake table of the exciter, which is controlled from the panel at the left, to determine if simulated engine vibration will cause the unit to malfunction. The large MB exciter has the capacity to exert a vibratory force of 2500 pounds, with a frequency range up to 500 CPS. A smaller MB exciter, shown on the bench in the background, is rated at 50 pounds peak force available to 2000 CPS.

• • •

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West Point of the Air

by Jack M. Kerr
Cer. E. '56

With the present day emphasis on airpower in offense and defense, the Air Force has assumed a prominent position. It is being expanded enormously and needs officers badly.

At the present, the Air Force gets most of its officers from the Aviation Cadet programs and the Air Reserve Officers Training Corps. They also receive one-fourth of the graduating class at West Point and Annapolis, but even this number is no where near sufficient.

The Air Force needs and desires an Air Academy. This would be operated in the same general way as West Point and Annapolis and would, indeed, be a West Point of the Air Force. The men would be selected for the academy by the same method now used for appointment to West Point and Annapolis. This requires an appointment by a senator or congressman and a very stiff entrance exam.

So far the academy is only on paper. The permanent location has not been decided upon. In fact, the decision upon the site has become more and more a political battle between states and cities within these particular states. In all, the Air Force has four hundred proposed sites to consider. One of the important ones is right here in the Champaign-Urbana area in Illinois. Another under consideration here in Illinois is near Elsah, Illinois. This is near the Mississippi River.

Until the permanent academy is started, the Air Force plans to start a small one with a small beginning class of 250 to 300. However, it is hoped that by 1959 the first group of Air Force officers will be graduated from the permanent academy.

Despite its needs, the Air Force may face difficulties in obtaining money for its new academy. The legislation authorizing the academy swept through the House of Representatives by a majority of 329 to 36 and went through the Senate by a large majority. In spite of this, the chairman, John Taber, of the House Appropriations Committee and Chairman Evarett Scrivner of the Air Force Appropriation Subcommittee are both opposed to the new academy.

Scrivner claims the academy will cost a total of 350 to 400 million dollars instead of the 125 to 175 million the Air Force estimated. In addition, he objects, it will cost about the same amount to operate as the 16.5 million dollars a year to operate Annapolis.

Also opposed to the Air Force Academy is Rep. Peter Mack, aviator enthusiast, who made a lone, globe-girdling flight in a Beech Bonanza in 112 days a few years ago. Mack claims that what is needed is consolidation of West Point and Annapolis into one military academy for all the services.

Though there is some opposition to the proposed academy, it is assumed that the Air Force is assured of one and the present problem is picking a site. There is a commission of five persons making inspection trips all over the country now and it is expected that when their report is turned in the new Air Academy will be started.

Then there was the C. E. who went mad looking for a place to put a corner stone in a roundhouse.

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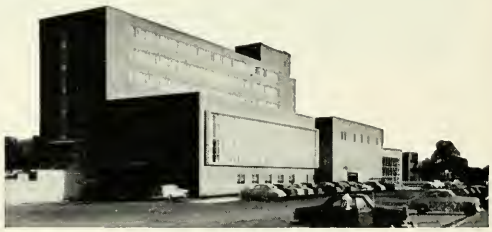

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SPEED LIGHT

by Jack Siebert, E.E. '57

The human eye is incapable of seeing many things which frequently occur in daily life. A golf ball leaves the club traveling at a velocity somewhere in the neighborhood of 180 ft sec. Not only is the human eye unable to see it, but the ordinary camera is unable to photograph it. The best mechanical shutter has a top speed of about 1/1000 of a second. During this time interval the golf ball would move 2 inches, and in a picture would appear as a white blur 2 inches long. For a reasonably sharp picture the ball should not move more than 1/50 of an inch. The ball moves, however, 1/50 of an inch in 1/100,000 of a second, which is the exposure necessary to take the picture.

Inertia and material strength prohobit such high shutter speeds by mechanical means. They can be obtained, however, by exposing the photographic film with a bright light source which is turned on for only a minute fraction of a second. By utilizing electronics, speedlight, sometimes called strobe-light or electronic flash, provides this light source. A speedlight is sort of an "electronic flash bulb," which makes possible extremely short exposures.

In 1832, Plateau of Ghent and Stampher of Vienna discovered independently that lines drawn as radii at equal intervals on a rotating wheel could be made to appear motionless if they were viewed through slots cut in the same position as the lines on a similar wheel turning at the same speed. Furthermore, if the slotted wheel was slowed down the lines appeared to rotate forward, and if it was speeded up they seemed to rotate in the reverse direction. Plateau, who went blind from gazing at the sun too long, called this wheel a "phenakistoscope." Stampher called it a "stroboscope," which is Greek for "whirling watcher." Stroboscope is the named used today. It was not long before someone used the stroboscope to interrupt a beam of light, thereby producing the first stroboscopic light.

The motion picture was conceived from the stroboscopic effect. If in a motion picture an automobile or wagon wheel appears to be revolving backwards, it is due to the fact that the camera is taking more frames per second than the wheel is making revolutions. Both the stroboscope and the motion picture are possible only because of retinal lag, the ability of the human eye to retain an image for 1/16 of a second before it fades away.

Wm. Henry Fox Talbot, in 1851, produced an electric spark which was of short enough duration and of sufficient intensity to photograph a clipping of the *London Times* which was fastened to a revolving fan. Spark photography of this type was a positive step towards the speedlight of today, and is still used for certain scientific purposes.

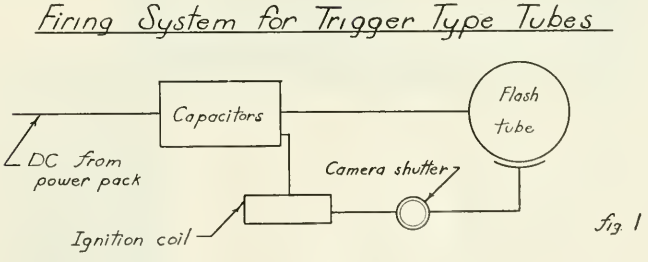
In 1931 Harold E. Edgerton, of the Massachusetts Institute of Technology, built an electronic stroboscopic light to examine moving machinery parts. Each pulse of light was very bright and of short duration, and it was found that pictures could be taken with them. This was the first electronic speedlight, and made possible the birth of high speed photography as it is known today.

The basic principle behind electronic flash is not complicated. Electrical energy is gathered in small quantities, stored up until a large amount is on hand, and then allowed to escape all at once. When it escapes it produces a spark in a gas filled tube; consequently, a flash of light is emitted. The three fundamentals of a speedlight unit are as follows: a power source, a means to store the electrical energy, and a flash tube to discharge it.

The task of the power source is to furnish high voltage direct current. Depending upon whether the speedlight unit is to be portable or stationary, the primary power source will be either batteries or house current. Units which utilize house current alone are usually the larger types of equipment and require 2000-2300 volts DC. This voltage is obtained by using a transformer to convert 110 volts AC into high voltage AC which is then changed to DC by a rectifier. Power packs using batteries usually are called upon to supply from 450-900 volts DC, and may be of several types. Among these are the high voltage dry battery pack and the low voltage vibrator pack. The high voltage battery is the simpler of the two, for it incorporates only a battery which supplies a sufficient voltage of direct current. The low voltage vibrator unit, on the other hand, uses small low voltage cells as a power source. The direct current these cells furnish is converted into alternating current by a vibrator which draws its power from the cells. This AC is then fed into a transformer which delivers high voltage AC which is rectified to obtain direct current.

Although dry cells are becoming more common, miniature spill proof storage batteries are often incorporated in speedlight units. These batteries may be charged up to 200 times. As a convenience some speedlights have a battery charger built right into the power pack.

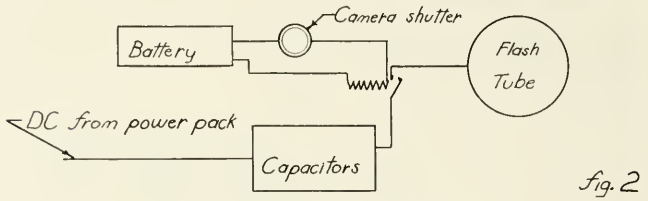
The electrical energy delivered by the power source is stored in capacitors. A



Circuit diagram for trigger type tubes

capacitor (condensor) is a device which receives electricity in small amounts, retains it until a large amount is present, and discharges it instantaneously. This process is analogous to filling a drinking glass with a trickling stream of water and then dumping it all at once.

Two types of capacitors are used in electronic flash. They are the oil capacitor and the electrolytic capacitor. Electrolytic capacitors are made of two long sheets of aluminum foil with chemically treated gauze between them rolled into a cylinder. When an electric current is introduced to the capacitor a film forms on the aluminum foil. This process is called forming the condensor. The film, which is necessary for the operation of the capacitor, has a tendency to deform; therefore, the capacitor must be used occasionally to keep it in good working order. Electrolytic capacitors are used in units which operate on voltages of 450-900 volts DC. For larger units which require higher voltage, (2000-2300 volts DC), oil capacitors are used. These capacitors use a special type of paper for an insulator and the whole unit is submersed in a can of oil and sealed. Oil capacitors are considerably heavier than the electrolytics. All capacitors have a tendency to lose their charge. This loss, called leakage, is very slight in oil capacitors, but reaches a rather high percentage in the electrolytic type. As the power leaks out it is necessary for the battery to replace it, and therefore an electrolytic capacitor which is not operating at peak efficiency tends to drain the battery.



Circuit diagram for self-ionizing tubes

If similar capacitors are wired in parallel the total capacitance is equal to the sum of the capacities and the operating voltage remains constant. If two similar capacitors are wired in series the capacitance is the same as one-half that of one of them and the operating voltage is doubled. Speedlight design usually calls for either two or four capacitors. Several methods of connecting them into circuits are shown in Fig. 3.

The capacitor is discharged through a glass tube which contains an inert gas. When this occurs the gas ionizes and allows a spark to jump across two electrodes in the tube. This spark is what produces the light. Two types of flash tubes are commonly in use. These are the low voltage trigger type and the self-ionizing type.

In a speedlight unit designed to use the low voltage trigger tube the capacitors are always connected to the flash tube. When the capacitors are charged the tube does not fire, however, because it has enough internal resistance to prevent the ionization of the gas. This resistance is present because the gas in the tube, usually Xenon, is confined under pressure. To fire the tube an ignition coil is used to place an extra high voltage charge on the tube, which breaks down the internal resistance. This ignition coil, or iginition transformer, draws its power from the capacitors' discharge, which is from 450-900 volts DC.

The self ionizing flash tube operates at higher voltages, usually 2000-2300 volts DC. The capacitors are not permanently wired to the tube, for all that is needed to fire the tube is to allow them to discharge through it. This is due to the fact that the gas in the tube is not under as much pressure as the trigger type, and therefore has less internal resistance.

A complete low voltage speedlight unit features a battery power pack, (a house current power source may be incorporated if portability is not of importance), electrolytic capacitors, a trigger type of flash tube, and an ignition transformer which is connected to the flash tube through the camera's shutter contacts. (See Fig. 1.)

A unit utilizing a self ionizing flash tube employs a higher voltage power pack, oil capacitors, and a relay through which the shutter contacts can connect the capacitors to the flash tube. (Fig. 2.)

The efficiency of a speedlight is rated by three units: watt-seconds, lumen seconds, and guide numbers. A watt-second is a measure of energy the unit can store, and is defined by the equation: watt-seconds=CE^2 over 2, where C is the capacitance in microfarads and E is the

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voltage in kilovolts. A lumen second is a unit of light output. A 100 watt-second speedlight may furnish about 4,000 lumen seconds, about the same as an SM flash bulb. The guide number is an aid to judging exposure. It is an indication of the effectiveness of the entire speedlight and is dependent to a great extent upon the efficiency of the reflector used on the flash gun. Some reflectors may increase the intensity of a flash tube by as much as 600%.

The time duration of the flash varies directly as the capacitance of the unit and the internal resistance of the flash tube. It is given by the equation: $T=RC$, where T is the time duration in microseconds, C is the capacity in microfarads, and R is the resistance in ohms.

As an example of the flexibility of speedlight construction, consider two speedlights which both employ four electrolytic capacitors, each having 165 microfarads capacity and operating at 450 volts. Both speedlights use the same flash tube, which has a resistance of 4 ohms. The first speedlight has the capacitors wired in parallel and therefore has a total capacitance of 660 microfarads at 450 volts. By substituting in the watt-second formula it can be shown that this unit has a rating of 66 watt-seconds. The duration of the flash is the capacity times the resistance, which is 2640 microseconds, or about 1/384 of a second. The second speedlight has the capacitors wired in series-parallel, which makes its total capacity 165 microfarads at an operating voltage of 900 volts. This unit has the same 66 watt-second rating as the first one, but has a flash duration of 165×4 microseconds, which is around 1/1500 of a second. Although the second unit has a shorter flash duration than the first, it requires a higher voltage. As the operating voltage increases, the weight and expense of the power pack also rises, and since extra high speeds are not required for general photographic use, commercial speedlights tend to keep the flash duration around 1/500 to 1/10,000 of a second.

The power consumption of a speedlight is given by the formula: Power consumption = watt-seconds / condenser charging time. The power discharge is obtained by using the formula: Power discharge = watt-seconds / flash duration. Using these relationships it can be seen, for example, that a 100 watt-second speedlight having a flash duration of 1/5,000 second, and whose capacitors take 5 seconds to charge, would consume 20 watts of power and deliver 500,000 watts (instantaneous power) for each flash.

A variety of speedlight units are available commercially. They range in price from as little as $35.00 to over $300.00. Most of these units are portable, employ low voltage flash tubes, and are rated from 40-110 watt-seconds. The number of flashes which can be made a minute is dependent upon the charging time of the capacitors, which varies from 2 to 20 seconds. Commercial speedlights have neon ready lamps which glow when the capacitors have reached their required charge. Flash tubes have an average life of over 10,000 flashes, the cost of each flash being between ¼c and 1.5c. Some speedlights are designed to be used with cameras having "X" (zero delay) synchronization contacts built into their mechanical shutter. Other units are adjustable for 5-35 millisecond delay.

Speedlight has proven worthwhile in numerous fields of photography. Its first use was in scientific research. Scientific speedlight has attained speeds as great as one millionth of a second. An idea of how short a time duration this is can be seen by letting 3,000 miles, the distance from New York to San Francisco, equal one second. One millionth of a second is then about 15 ft.—the distance across a living room. Such high speeds are used to photograph such things as projectiles in flight and rapidly moving machinery. Giant speedlights were used in World War II to take aerial photographs at night from altitudes as great as 12,000 ft. Electronic flash tubes yield light which has a bluish cast to it. This light has a temperature of about 7,000 degrees, which is very near the quality of sunlight. Because of this fact many photographers use daylight color film without using filters. Sports photographers use speedlight because it has excellent action stopping ability and because it eliminates carrying and changing flashbulbs. The human eye requires that a light be continuous for at least 4/100 of a second for it to appear at full intensity. Therefore, a light which is on for only about 1/2000 of a second will appear only 1/200 of its full intensity. Due to this fact speedlight has been accepted by the portrait photographer. The subject does not have to squint his eyes of bright, hot, and distracting floodlamps; consequently, a more natural portrait is obtained. Speedlight also eliminates the need for holding still, and is consequently an aid in photographing children.

As with any other equipment speedlight has its disadvantages. With units using line voltage a variation of 10% in line voltage can mean a 20% variation in light output. Battery power packs are heavy, and carrying one can become quite tiresome. Film which is exposed by electronic flash has a tendency to be lacking in contrast, and therefore must be developed up to 50% more than normal. In an overall picture, however, the advantages of speedlight far outweigh the disadvantages, as attested by the fact that it is rapidly gaining in popularity.

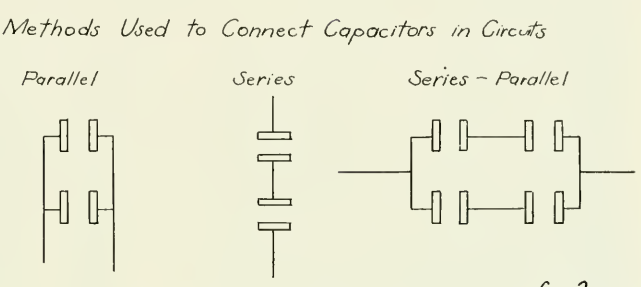

fig. 3

Methods of attaining different voltoges and quantities of charge on capacitors

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EDITORIAL

Design Engineering Experience Is Valuable Executive Training

The ever increasing demand for executive leadership is being met successfully in many industrial organizations by recognizing the capacities and potentials of the design engineer. The validity of this method of selecting company leaders is justified when you analyze the every day problems that parallel the designer and a company executive.

The pivotal point in your engineering career will occur when you visualize the results of your work by observing the characteristics of the finished product. The realization is attributed to the decisions you have made regarding the basic design of the component parts, cost analysis and availability of materials, production procedures adapted to your company's manufacturing facilities, maintenance considerations when the finished product is subjected to customer service, and proto-type units designed for the replacement market when the original equipment reaches obsolescence. In directing the company's overall activities, the executive is faced with the same basic types of problems, in addition to other duties required of him regarding the correlation of product priorities and budgetary measures.

As the design engineer becomes experienced, he realizes that the academic solution to an engineering problem does not completely satisfy all of the requirements of competitive product design. In many cases the final decisions are determined by the economic structure relating to the proposed design and its market potential. The achievement of creating an acceptable design demands a thorough analysis as well as sound judgement and competence from the designer. These characteristics are also important prerequisites for executive leadership.

Ernest J. Massard

DESIGN NEWS—JUNE 15, 1953

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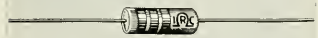
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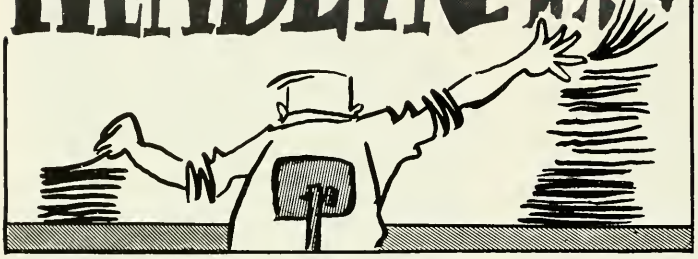


edited by Larry Kiefling, M.E. '56

Machining Hard Materials

Machining operations on brittle or extremely hard materials that are difficult and even border on the impossible, can now be performed with a high speed, high precision ultrasonic machine tool. Using ultrasonic vibrations in combination with abrasive particles in suspension the machine tool can produce through holes, blind holes, and contoured cavities in ceramics, glass, and precious stones, as well as in carbides and other fused and sintered materials or any metal or alloy. Low cost, soft steel cutting tools are used to duplicate the most exacting contours.

Extensive use of complex feretic metals in the electronics field has created many problems which, due to the extreme brittleness of some of these materials, cannot be solved with ordinary machining methods. Using the ultrasonic machining technique it is possible to drill, slice, carve or cut off such metals or materials to various shapes or sizes.

Sectors of materials used as separators in an electrical conduit have been machined with a penetration rate of $\frac{1}{8}$ inch per minute. The operation has given consistent results which are remarkable in view of the properties of this material. A high degree of precision, elimination of chipping of the work material, and fine surface finish are some of the advantages which this ultrasonic machine tool offers. The accompanying photograph shows typical parts and operations which have been machined with this method. The dimensional accuracy in both size and location has been held to plus or minus .001 inch on these jobs.

Miniature Radio

A small radio receiver, which can be worn like a hearing aid, has been developed by two General Electric engineers.

W. F. Chow and J. J. Suran, who built the radio in the company's Electronics Laboratory, said it was designed primarily for use in civil defense where a compact lightweight receiver, operating from a minimum number of standard flashlight batteries, is desired.

The radio, described as an experimental model, is tuned to a single broadcast frequency, 1260 kilocycles, which is one of two channels to be used by radio stations in broadcasting civil defense instructions to the general public during emergency periods.

The radio has a hearing-aid type ear phone and weighs about five ounces. It can be slipped into a shirt or vest pocket, and is said to be capable of continuous operation for more than a month without battery replacement.

Two tiny batteries, like those used in a pen-size flashlight power the radio. Long battery life is accomplished through use of germanium devices (a transistor and double-based diode) which do the radio detection and amplifying work with less power requirements than conventional radio tubes.

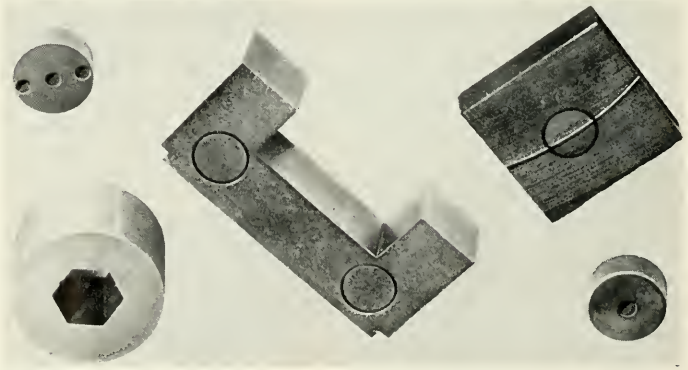
Chow and Suran say the radio needs further development before it can be considered for mass production.

Tougher Plastic

Irradiated polyethylene, representing a notable advance in heat and chemical resistance over normal polyethylene, is now being offered experimentally in narrow film form.

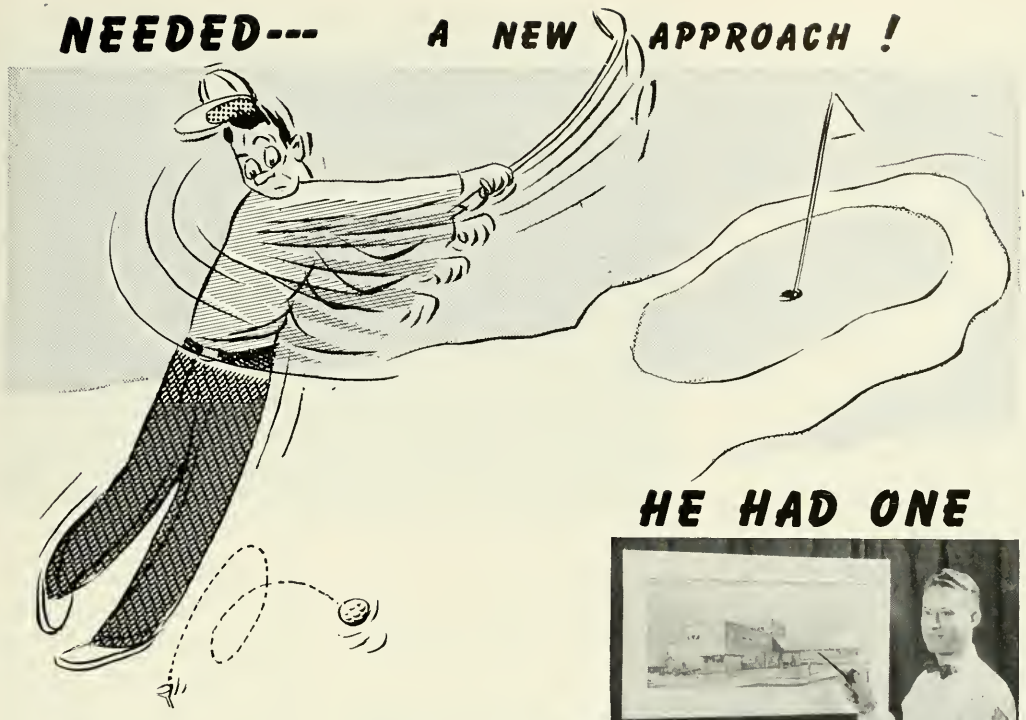
Designated "Irrathene" the new material's superior properties result from bombardment of polyethylene with high-energy cathode rays from million-volt electron generations.

Cross-linking or vulcanization of the polymer during irradiation contributes

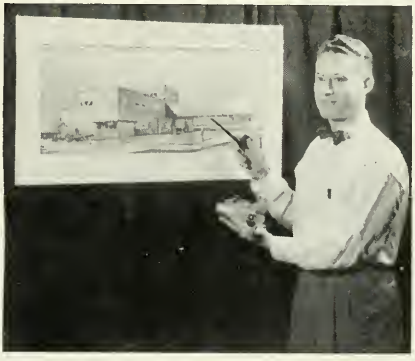


These pieces were cut with an Ultrasonic Machine Tool. (Courtesy of the Sheffield Corp.)

NEEDED--- A NEW APPROACH !



HE HAD ONE



LAMAR A. RAMOS, JR.,
Sr. Design Engineer—Airplane Engineering Division
B.S.P.E. Lousiana State U. 1941
B.S.A.E. Georgia Inst. of Technology 1947

Seen here examining the architect's sketch of our recently completed Wind Tunnel, Lamar's approach in solving complex and often unique aerodynamic problems has marked him as an engineering asset to M.A.C.

In 1947, he was first assigned to the XF-85 "Parasite" fighter, model of which he is holding above, and has since contributed his aerodynamic talents to most of our airplane engineering projects. He is presently a Group Leader concerned with the aerodynamic design of aircraft proposals. We need more young engineers like Lamar Ramos, *engineers with a new approach.*

Variety of Work is one important advantage of joining M.A.C.'s engineering team. The career opportunities in our three engineering divisions—Airplane, Helicopter and Guided Missile—are so varied that practically all types of engineers may be placed in a satisfying assignment, one charged with technological impact and challenge to ability. Every effort is made to place each engineering graduate in the division and assignment of his choice.

Variety of Living in beautiful suburban St. Louis can also be yours. M.A.C. engineers are encouraged to seek advanced degrees at one of St. Louis' fine universities. The educational, cultural, medical and recreational facilities available in this city are unparalleled elsewhere.

If you're looking for our type of engineering—we're looking for you. Check your Placement Office for dates when our representative will visit your school. Ask him about the McDonnell Graduate Study Plan.
You may also write to:

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form stability at 300-350° F and resistance to cracking when irradiated polyethylene is stressed and in contact with solvents or other active chemicals.

In the form of insulating tape and packaging film, irradiated polyethylene is expected to be a factor in the development of smaller electrical equipment with improved operating characteristics, and in the creation of radically new heat resistant and sterilizable transparent containers for foods, drugs, and pharmaceutical products.

A discovery of the General Electric Company's Research Laboratory, irradiated polyethylene film has been subjected to intensive product and process development recently. Division general manager Robert L. Gibson said that the new plastics will be available in limited pilot-plant quantities this year, and that large-volume production at low cost can be envisaged in the near future.

Believed to be one of the first industrial uses of electron irradiation, irradiated polyethylene is expected to expand industrial and consumers use of polyethylene plastics, already predicted as the first billion-lb. plastic material.

While present emphasis is on film—work is being continued on other fabricated forms of irradiated polyethylene, such as bottles, housewares and tubing.

Drawing Tungsten wire to .0003 inch diameter. (Courtesy of Western Electric)

.0003 Inch Wire

Tungsten wire so fine that it is nearly invisible is made on this automatic equipment. The plastic tank at left on the bench is divided into four sections, the first three of which contain etching solution of sodium hydroxide and sodium chloride while the fourth section holds water for washing the wire. The black unit to the right of the tank together with the electrical control panel above comprise the resistance measuring apparatus that controls the diameter of the wire and automatically determines the voltages applied to the solutions in the etching tanks. Wire approximately .0005 inch in diameter, the finest commercially made by drawing, is fed into the tanks from the spool at left. After being etched and washed it emerges from the measuring unit a mere .0003 inch in diameter or smaller as required. This dimension, incidentally, must be accurate to within plus or minus 0.00001 inch. Wire this fine is used in making grids for 416-type electron tubes, which are at the heart of the Bell System microwave radio system for both television and telephony.

Pure Germanium

Germanium, the metallic substance from which transistors are made, is purified in this production apparatus, patterned after the original laboratory model. This process, known as zone refining, produces germanium that is 99.9999995 per cent pure—the highest degree of purity ever attained in a manufactured product. In zone refining an ingot of germanium, which previously has been reduced from germanium dioxide, is passed through a heat zone so that a molten section traverses the length of the bar, carrying impurities with it and leaving a solidified section of higher purity. By use of multiple heating zones in tandem, a number of molten sections tra

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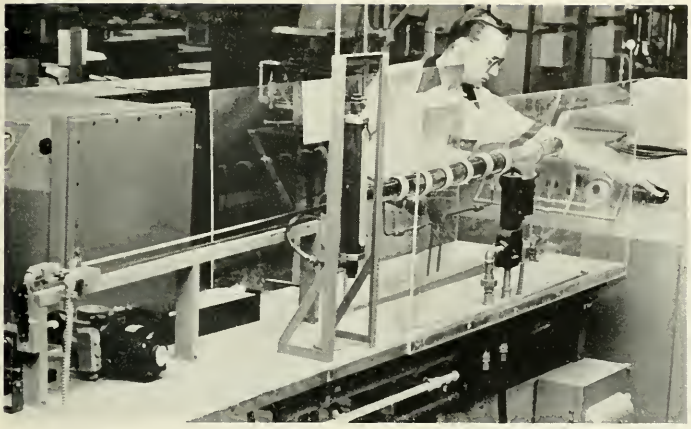

Zone refining of Germanium to an almost pure state. (Courtesy of Western Electric)

verse the bar, and as the germanium passes through each heat zone its impurity content is progressively reduced. In the apparatus shown, six induction coils are wound on a clear quartz tube. During zone refining, germanium is pulled through the tube in a graphite boat.

Subscribe to The Technograph

ENGINEER'S WHISKEY TEST

Connect 20,000 volts across a pint. If the current jumps it, the product is poor.

If the current causes the precipitation of lye, tin, arsenic, iron slag, and alum, the whiskey is fair.

If the liquor chases the current back to the generator, you've got good whiskey.

Guide: "We are now passing the largest brewery in the state."

Engineer: "Why?"

* * *

Scotsman: (at riding academy) "I wish to rent a horse."

Groom: "How long?"

Scotsman: "The longest you've got, laddie. There are five of us going."

* * *

The editor was admonishing his son, who was reluctant about attending school.

"You must attend every day and become a great scholar," lectured the fond father, "othewise you can never be an editor. What would you do, for instance, if your magazine came out full of mistakes?"

"Father," said the son, "I'd blame the printer."

And upon hearing these words the father wept with joy, for he knew he had a successor for the editorial chair.

* * *

She was only a gravedigger's daughter, but you ought to see her lower the beer.

* * *

"Would you like to see a model home?"

"Glad to. What time does she quit work?"

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The Technograph needs men and women interested in gaining experience in:

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Welded Steel Designs Cost Less because:

1. Steel is 3 times stronger than gray iron.
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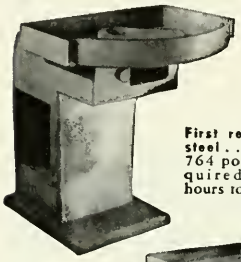
3. Steel costs a third of iron.

Ultimate savings are limited only by the ingenuity of the designer.

SIMPLIFIES DESIGN CUTS FABRICATING COSTS WITH WELDED STEEL

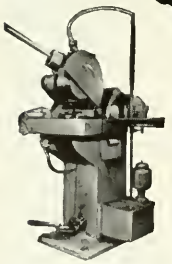
The successful industrial designer is one who can suggest ways of cutting the costs. That's why the engineer who knows how to utilize savings through welded steel finds his designs readily accepted.

Here, for example, is how steel design has eliminated 356 pounds of metal in the manufacture of the base for this machine. All former machining has been eliminated. There are no bolted joints to cause leakage of coolant. Cost of manufacture has been cut 20%.



First redesign to steel . . . weighed 764 pounds. Required only 31 hours to fabricate.

Final design more compact in construction, weighs 692 pounds . . . takes less floor space, requires only 24 hours to fabricate.



Original design required 1048 lbs. of castings bolted together. Each casting required costly machining and fitting.

HOW TO PUT STEEL'S SAVINGS TO WORK—

DESIGN DATA for welded construction is available to engineering students in the form of bulletins and handbooks. Write:

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THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

H. G. WELLS

Scientist . . .

Author . . .

Philosopher . . .

Herbert George Wells, the author of the famous book and radio play "War of the Worlds," was born in Bromley, Kent, 1868.

Young Wells had to study and work hard to escape poverty, and by the time he was 13 was apprenticed to a draper. Three years later he became an assistant master at Midhurst Grammar School. Not long after, he won a scholarship to the Royal College of Science. He transferred to the University of London where he graduated with a bachelor of science degree with honors.

His first main type of writing was done in the infant field of science fiction. Such novels as "The War of the World," "The Time Machine," "The Island of Dr. Moreau," "The Invisible Man," "When the Sleeper Wakes," "The First Men in the Moon," "The Food of the Gods," "In the Days of the Cornet," and "The War in the Air."

By 1908 Wells had adapted a completely new type of writing because he had broken away from the Fabian group of socialist; and philosophy, sociology, and world problems were greatly on his mind. As propaganda against the Fabians, Wells wrote "This Misery of Boots," "Socialism and Marriage," and "New World for Old."

Most of his writing after World War I was influenced by the war. During this period he wrote "God the Invisible King," "Joan and Peter," "The War that will End War," "The Salvaging of Civilization," and "The Open Conspiracy."

Despite all the laws of economics, women without principle continue to draw considerable interest.

* * *

At the zoo, a kangaroo suddenly jumped over the fence and ran away. The keeper hurried up and said to a lady standing in front of the cage: "What did you do to make him run away like that?"

"Why," she replied, "I just tickled the kangaroo's stomach a little."

"Well, you had better tickle mine a little then, lady," said the keeper, "because I've got to catch him."

* * *

Market report: Dressed poultry is up 2 cents a pound, but live pigeons continue to drop a little.

* * *

God made a machine, the machine made men,
Doctors, lawyers, priests, and then,
The devil got in and stripped the gears
And turned out the first batch of ENGINEERS.

* * *

Owner: "How did you come to puncture this tire?"

Chauffeur: "Ran over a milk bottle."

Owner: "Didn't you see it in time?"

Chauffeur: "No, the kid had it under his coat."

"Do you engineers need a blueprint for everything?"

"We Hit the Jackpot *in* Allis-Chalmers Graduate Training Course!"

say N. W. MORELLI

Oregon State College, B.S.,M.E.—1950

and

E. R. PERRY

Texas A. & M., B.S.,E.E.—1950

WHILE taking the course, two engineers developed a revolutionary new circuit breaker mechanism.

"Our experience shows what *can* happen if you work with people open to suggestion. We found men of this kind at Allis-Chalmers, and it has given us a special pleasure in our job.

"We started out like most other graduates with a hazy idea of what we wanted to do. After working in several departments, we requested that part of our training be at the Boston Works of Allis-Chalmers, where circuit breakers are made."

New Design Principle

"Circuit breakers soon became an obsession with us, and we got the idea of designing a hydraulic operator and triggering mechanism for these breakers. Most operators for big breakers are pneumatic.

"Unsuccessful attempts had been made in the past by all circuit breaker manufacturers to build hydraulic operators. The important thing is that no one at Allis-Chalmers said, 'Don't try it—it won't work.' "

Start New Era

"To make a long story short, our study of the problem led us to the hydraulic accumulator and high speed valves being used by the aircraft industry. These had not been available when earlier attempts were made to build a hydraulic operator. With these highly developed devices to work with, we were able to build an operator that combined the best features of pneumatic and hydraulic operation. We call it the *Pneu-draulic* operator. Engineers are saying it starts a new era in circuit breaker actuation.

"This fact is important to us, but it is even more important to know that Allis-Chalmers Graduate Training Course is full of opportunity . . . and as we found out, there's opportunity right from the start."

Pneu-draulic is an Allis-Chalmers Trademark.

Low-pressure spindle for a 120,000 kw steam turbine generator. Said to be one of the largest ever built in the United States, this spindle is nearing completion in the Allis-Chalmers West Allis shops.

Facts You Should Know About the Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

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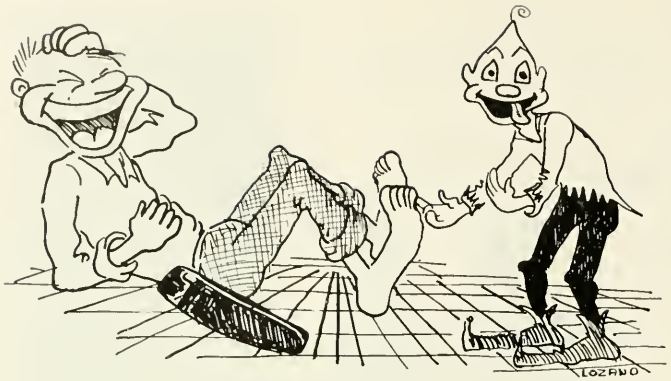


TECHNOCRACKS

No matter how low the dollar may fall, it will never fall as low as some people stoop to get it.

* * *

Her: (At Prom) "Wait here for me, Bill, while I go powder my nose."

Her: (Three dances later) "Have you been waiting long?"

Him: "No, but I've been looking for you to give you your compact."

* * *

"What did you do before you came in the service, mister?"

"Sir, I made square marbles for kids who would rather shoot dice."

* * *

Chem. E.: "Every time I kiss you it makes me a better man."

Co-ed: "Why try to get heaven in one night?"

* * *

Col. Brook: "Cadet, where's the balance of your rifle?"

Coddington: "This is all they gave me, sir."

* * *

"Why did you throw the pot of geraniums at the plaintiff?"

"Because of an advertisement, your honor."

"What advertisement?"

"Say it with flowers."

* * *

A motorist was picked up unconscious after a smash an dwas being carried to a nearby filling station. Opening his eyes enroute, he began to kick and struggle desperately to get away. Afterward he explained that the first thing he saw was a "Shell" sign, and "some damn fool was standing in front of the 'S'."

* * *

First He—"What's hi sposition?"

Second He—"He's the third assistant guesser in the Weather Bureau."

"Pa, what does it mean here by diplomatic phraseology?"

"My son, if you tell a girl that time stands still while you gaze into her eyes, that's diplomacy; but if you tell her that her face would stop a clock, you're in for it."

* * *

You know what the once over is?
That's this!
when like
you girl
look at a pretty

* * *

A drunk lying on the floor of a bar began to show signs of life, so one of the customers smeared a little limburger cheese on his upper lip. The drunk slowly arose and walked out the door. In a few minutes he came back in. Then he went out again, only to wobble back in a few more minutes. Shaking his head with disgust he said, "It's no use. The whole world stinks."

* * *

Sandy McDougal was so thrifty, when he invited his friends over for a beer, he put a coin slot on his bathroom door.

* * *

A speech is like a girl's skirt. It has to be long enough to cover the subject, and short enough to hold your interest.

* * *

Two editors gazed admiringly at the beautiful dress of the chorine.

"Who made her dress?" one asked of his companion.

"I'm not sure, but I think it was the police."

* * *

Professor: "If you start at a given point on a given figure and go all the way around it what will you get?"

Freshman: "Slapped, sir."

Soldier: "Say, you think you're a pretty hard guy, don't you?"

Marine: "I am. I wasn't born, I was quarried."

* * *

Two junior size "cats" were loitering on a street corner, when one said to the other:

"How old is you?"

"Ah's five," was the reply. "How old is you?"

"Ah don't know," said the first.

"You don't know how old you is?"

"Nope."

"Does women botha' you?"

"Nope."

"Youse fo'."

* * *

The day after finals, a disheveled EE waled into a psychiatrist's office, tore open a cigarette, and stuffed the tobacco up his nose.

"I see that you need some help," remarked the startled doctor.

"Yeah," agreed the student, "do you have a match?"

* * *

A very rich deposit of oil was discovered on the farmer's land. Immediately he rushed into town to purchase a new car. An obliging salesman showed him a sleek roadster selling for $5,000.

"I am prepared to pay cash," said the farmer. "Will I get a discount?"

"Why certainly," replied the salesman. "We will give you a 10% discount on a cash purchase."

Not being confident of his ability as a mathematician, the farmer said he would think it over and return later.

He walked into a restaurant and over his coffee tried to figure what his discount would be, but to no avail. Finally in desperation he turned to the waitress and asked, "If I gave you 10% of $5,000 how much would you take off?"

Blushing prettily, the waitress whispered, "Would my earrings bother you?"

* * *

A wealthy farmer decided to go to church one Sunday. After service, he approached the preacher with much enthusiasm. "Reverend, that was a damned good sermon you gave, damned good."

Reverend: "I'm glad you liked it, but I wish you wouldn't use those terms in expressing yourself."

Farmer: "I can't help it, Reverend. I still think it was a damned good sermon and I was so impressed that I put a hundred dollar bill in the collection."

Reverend: "The hell you did!"

* * *

"Waiter, there's a fly in my turtle soup."

"Yeah, we ran out of turtles."

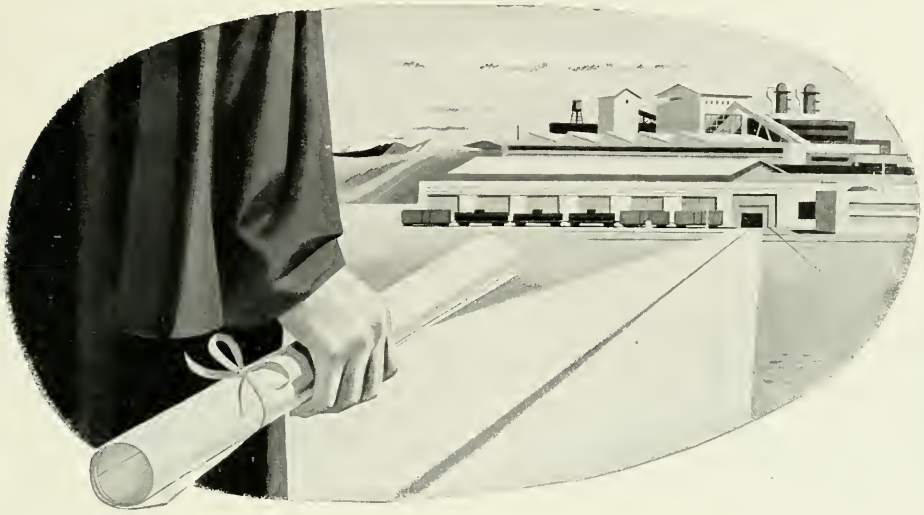
* * *

"Goodness, George, this is not our baby. This is the wrong carriage!"

"Shut up. This is a better carriage."

Spring thoughts on the subject of...

rambunctious sheepskins



AN engineering senior can hardly be blamed for feeling rambunctious now that the years of hard study are nearly over and the sheepskin's in view.

But the sheepskin comes at Commencement. Commencement means you're set to start on your career. And that's certainly worth some serious thought.

To help you decide which job to pick, you'd do well to weigh the many reasons for choosing an engineering career at General Motors—reasons like these:

- At GM, an engineer has a real chance to follow his natural bent and work in the field of his choice. That's because GM produces a variety of products — automobiles, trucks, Diesel engines, refrigerators, bombsights, just to mention a few.

- At GM, you get the chance to work closely with top engineers, sharing their knowledge and experience. That's owing to GM's decentralization: 34 manufacturing divisions, 117 plants in 57 towns and cities. Yet each division draws upon GM's vast central research laboratories.

- At GM, there's a congenial climate for the personal and professional advancement of engineers. We respect the engineering point of view, as shown by the number of key GM executives in both divisional and top management who began their careers as engineering graduates on GM drafting boards.

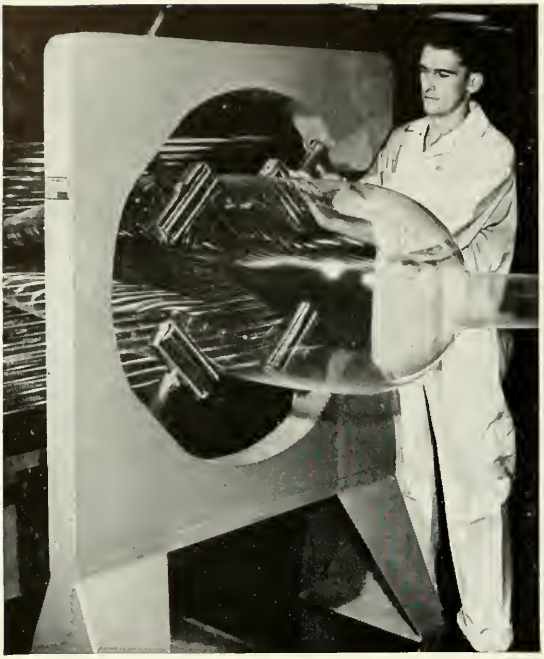
Naturally, all this spells genuine opportunity for the young man who has what it takes. Your College Placement Office can arrange an interview for you with our college representative. Or you can write direct to us.

GM positions now available in these fields:

MECHANICAL ENGINEERING
ELECTRICAL ENGINEERING
METALLURGICAL ENGINEERING
INDUSTRIAL ENGINEERING
CHEMICAL ENGINEERING
BUSINESS ADMINISTRATION

GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan



One of the early steps in the production of Saran-Wrap—the "bubble" that becomes a film after being deflated in a series of rollers.

Colorful display bins are an important part of consumer sales strategy and explain the advantages of Saran-Wrap.

TAKING CHEMICALS TO MANY MARKETS...

Dow succeeds through the careful coordination of group effort in research, marketing and sales

The high consumer acceptance gained by Saran-Wrap is a current example of what happens when extensive research and production planning is followed by coordinated marketing and sales strategy in launching a new product.

This amazing new plastic food wrap is certainly a useful product—but it is much more than that. For Dow it marks another milestone in a continuing effort to move into new fields of endeavor and to increase the variety as well as the size of its operation. Well-planned and executed projects, introducing varied industrial and consumer products, have been responsible for Dow's rapid growth to a position of prominence in the chemical industry.

Whether you choose research, production or sales, you can find a challenging career with Dow. Write to Dow's Technical Employment Department today for the booklet, "Opportunities with The Dow Chemical Company"—you'll find it interesting. THE DOW CHEMICAL COMPANY, *Midland, Michigan.*

you can depend on DOW CHEMICALS

DOW

Compatible color television will eventually reach every TV home

The rainbow you can see in black and white!

RCA brings you compatible color TV. Lets you see color programs in black and white on the set you now own!

"When a modern and practical color television system for the home is here, RCA will have it . . ."

Echoing down through the years, these words—spoken in 1946 by David Sarnoff, Chairman of the Board of RCA—have a ring of triumph today.

Behind this great development are long years of scientific research, hard work and financial risk. RCA scientists were engaged in research basically related to *color* television as far back as the 1920's . . . even before *black-and-white* television service was introduced.

Since then RCA has spent over $25,000,000 to add the reality of color to black-and-white TV, including development of the tri-color tube.

The fruit of this great investment is the RCA all-electronic compatible color television system, *a system that provides for the telecasting of high-quality color pictures that can be received in full color on color receivers; and in black and white on the set you now own.*

RCA and NBC will invest an additional $15,000,000 during color TV's "Introductory Year"—1954—to establish this new service on a solid foundation.

RCA color sets are beginning to come off the production lines in small quantities. Although it will probably be another year before mass production is reached, the promise of compatible color television is being fulfilled.

RCA pioneered and developed compatible color television

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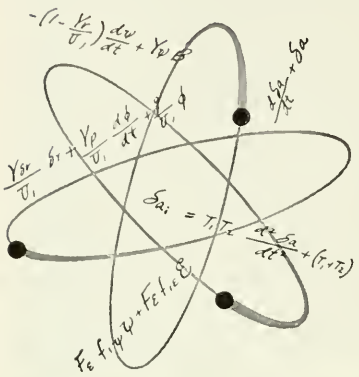


As science advances, and as our country continues to develop its industrial might, the business of automatic control gets bigger and increasingly important.

For the prime force behind the 20th century revolution has been and will continue to be *automatic control.*

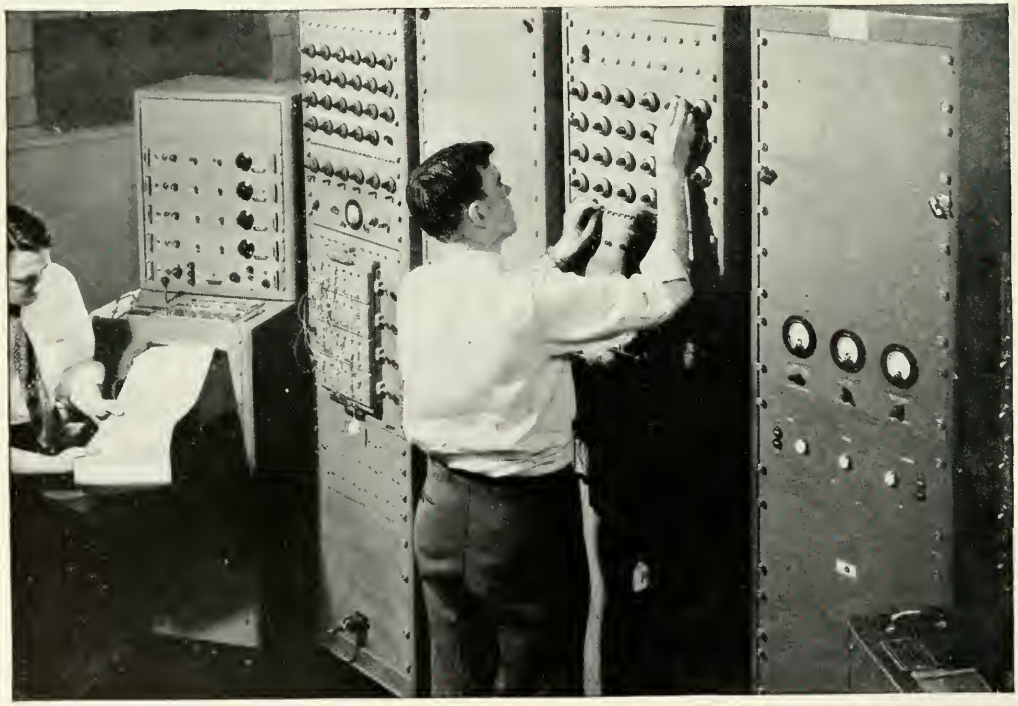
So at Honeywell, leader in this field for over 60 years, it of course means a bigger, more exciting, more challenging job ahead—all of which adds up to greater opportunities for engineers and scientists.

And that's why we're always looking for men with ideas and ambition to grow with us.

Here at Honeywell one out of ten employees is engaged in research and engineering activities.

Shown below is part of our Aeronautical Division's analog computing equipment, which helps our research engineers to develop and simulate flight tests on automatic controls for aircraft. It's typical of work being done by all of the company's eight divisions in plants across the country.

So if you're an engineer or scientist and like to use your imagination freely in such fields as electronics, hydraulics, mechanics, chemistry, physics, and a wide variety of others, be sure to send in the coupon below.



America lives better—works better—with Honeywell controls.

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First in Controls

MINNEAPOLIS-HONEYWELL REGULATOR CO.
Personnel Dept., Minneapolis 8, Minnesota

Gentlemen: Please send me your booklet, "Emphasis on Research" which tells more about engineering opportunities at Honeywell.

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Ever Study

TERRESTRIAL ENGINEERING?

Probably not. As far as we know, there isn't such a term. Even so, the terrain of a manufacturing plant may have a vital effect on the design and location of its engineering equipment.

It certainly did in the case of our Belle, West Virginia, plant, which is just across the road from a flat-topped hill, 750 feet high.

Perhaps you'd like to match wits with Du Pont engineers, for we feel that this problem was interesting—and its solution ingenious.

Briefly, the situation was this: Carbon dioxide was to be removed from a mixture of gases by bringing them into contact with water in "scrubbers" operating at 450 psi (gauge). The inlet gases contained about 25% CO_2 by volume. Because of its greater solubility, most of the CO_2 would leave the scrubbers dissolved in the water.

It was necessary to reduce the pressure of this water to atmospheric and recover the dissolved carbon dioxide, since CO_2 was needed for use in a chemical synthesis. The degasified water then had to be pumped back into the pressure scrubbers, to repeat the scrubbing cycle.

Still like to match wits? How would you design an economical closed system for this scrubbing water? After you've thought out your solution, you might like to compare it with the one given below.

Du Pont engineers made use of the precipitous terrain in this way: pressure on the water leaving the scrubbers was sufficient to force it up to the top of the hill for CO_2 recovery. The returning water thereby provided a pressure of approximately 325 psi (750 feet of head) at the base of the hill. This gift of pressure on the suction side of the water pumps resulted in considerable energy saving.

Do unusual problems such as this one challenge you and stir your enthusiasm? If they do, we think you'll be interested in technical work with the Du Pont Company.

Watch "Cavalcade of America" on television

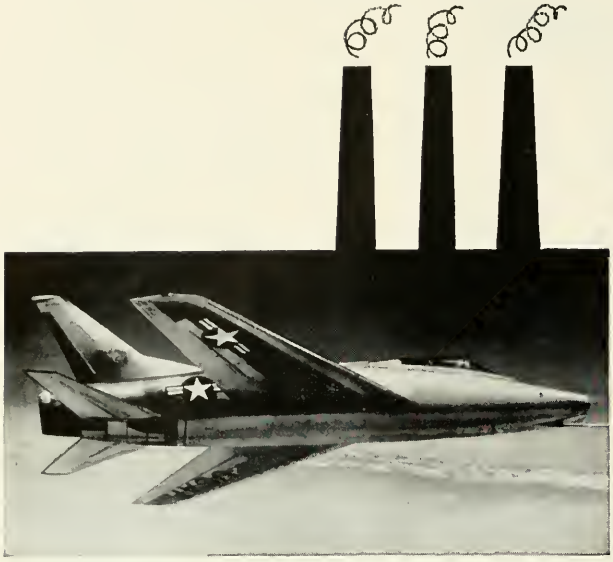
DU PONT

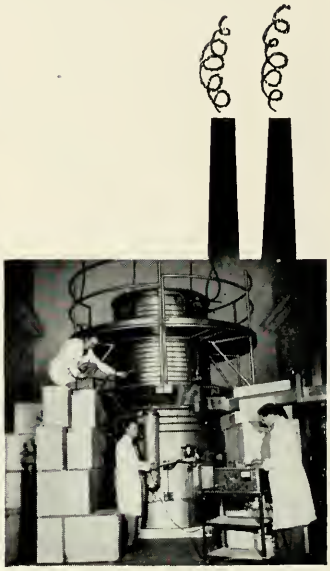
REG. U.S. PAT. OFF.

E. I. du Pont de Nemours & Company (Inc.)

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD





DIVERSITY CREATES OPPORTUNITY

Although best known for design and production of world-famous aircraft like the Korea-famed F-86 *Sabre* Jet and the new, record-smashing F-100 *Super Sabre* . . . North American Aviation also offers engineers excellent opportunities in other technical fields.

North American needs engineers with imagination and technical ability to help design and build the aircraft of the future. Other fascinating careers are created daily in its rapidly developing guided missile, jet, rocket, electronic and atomic energy programs.

When you are ready to enter the engineering profession, consider the well-paid opportunities at North American. Meanwhile, write for information on your future in the aircraft industry.

Contact: **Your College placement or write:**

Engineering Personnel Office, International Airport, Los Angeles 45, Calif.

or

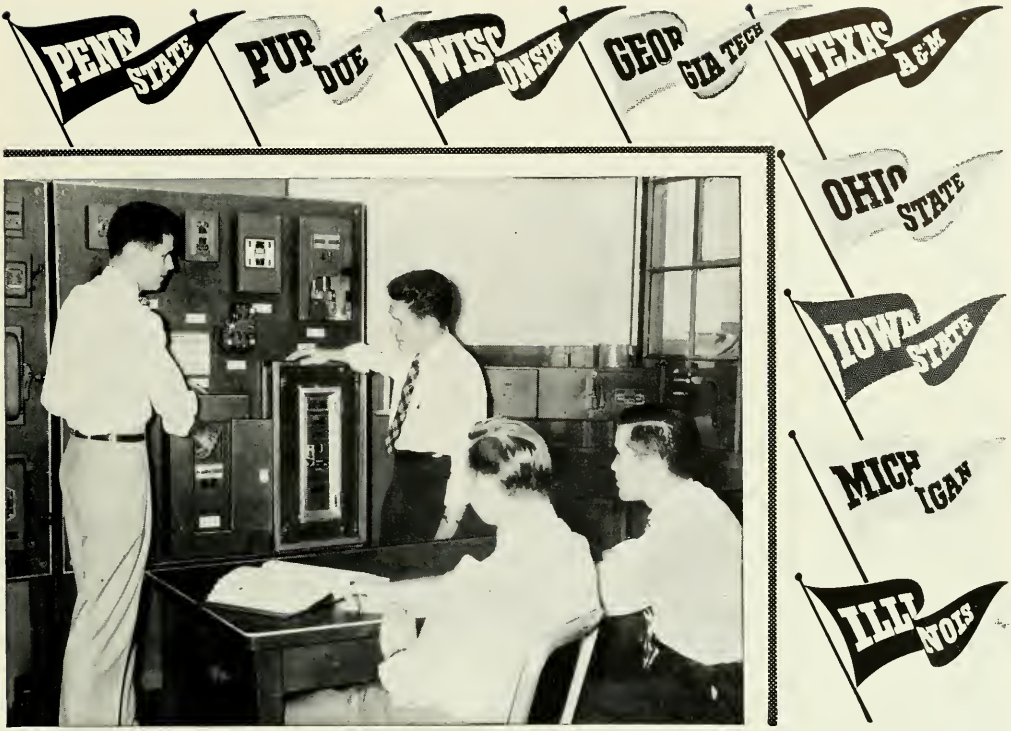
12214 South Lakewood Blvd., Downey, Calif.

or

North American Aviation, Inc. Columbus 6, Ohio

Organization, Facilities and Experience Keep **North American Aviation** *Years Ahead*

in aircraft . . . atomic energy . . . electronics . . . guided missiles . . . research and development



a Worthwhile Future... *with Training to Match!*

• If you are looking for a future with real opportunities for growth and advancement, Square D has a lot to offer. The potential growth and development of the electrical industry is tremendous. And Square D is a long established, top ranking name in that expanding industry. *Equally important, Square D offers the kind of personalized training that equips you to go far... fast!*

• • •

• We're looking for electrical, mechanical, general and industrial engineers with their feet on the ground and their eyes on the future. Are you one of them?

MAIL THE COUPON

We'd like to send you a 12-page "get-acquainted" brochure. It tells a lot about Square D, its products, services, markets and opportunities.

Square D Company, Dept. SA
6060 Rivard Street, Detroit 11, Michigan

I'd like a copy of
Square D's "Get-Acquainted" brochure.

Name_____

School_____ Class_____

Address_____

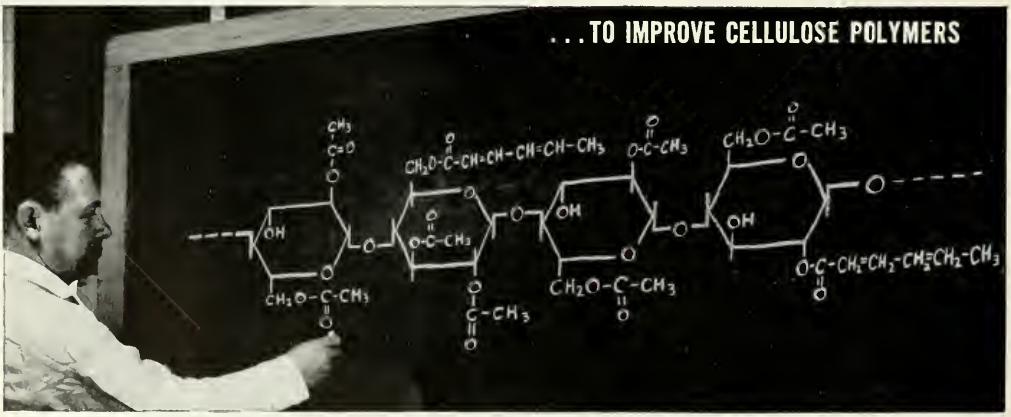
City_____ Zone_____ State_____

SQUARE D COMPANY

A new Hercules plant under construction at Burlington, New Jersey, will make the essential raw material for Canadian production of 'Terylene'—polyester yarn. Known as dimethyl terephthalate, or DMT, this basic chemical for polyester fibers will be made by an entirely new process, and will be available eventually for plastics and other uses.

HOW HERCULES HELPS...

Hercules' business today helps almost everyone's business. It embraces the production of synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products, and many other chemical processing materials—as well as explosives. Through close cooperative research with its customers, Hercules has helped improve the processing or performance of many industrial and consumer products.



Hercules now offers Hercose®S (cellulose acetate sorbate), a new film-former. Widely soluble, it can be applied as tough, flexible coatings and cured to insoluble condition. Hercose S films have excellent resistance to heat and low temperatures. It is another in the diverse group of Hercules cellulose chemicals offered many industries. Write for details.

HERCULES

HERCULES POWDER COMPANY Wilmington 99, Delaware

EC54-4

Foreground: Boeing RB-47E, world's fastest day-or-night long-range reconnaissance plane. *Background:* Standard B-47E six-jet bomber.

What do you want most in an engineering career?

Is it room to grow? Then join a company that's growing. Boeing, for example, has grown continuously throughout its 37-year history of design, production and research leadership. There's always room up ahead—and Boeing promotes from within. Regular merit reviews are held to give you steady recognition.

Do you want long-range career stability? Boeing today employs more engineers than even at the peak of World War II. Here you'd work on such projects as pilotless aircraft, research on supersonic flight and nuclear power for airplanes, on America's first jet transport, and the world's outstanding jet bombers.

Do you want variety of opportunity? Aviation is unique in this respect. It offers you unmatched variety and breadth of application, from applied research to production design, all going on at once. Boeing is constantly alert to new materials and new techniques, and approaches them without limitations. In addition, Boeing's huge subcontracting program—requiring engineering co-ordination—offers you contacts with a cross section of American industry.

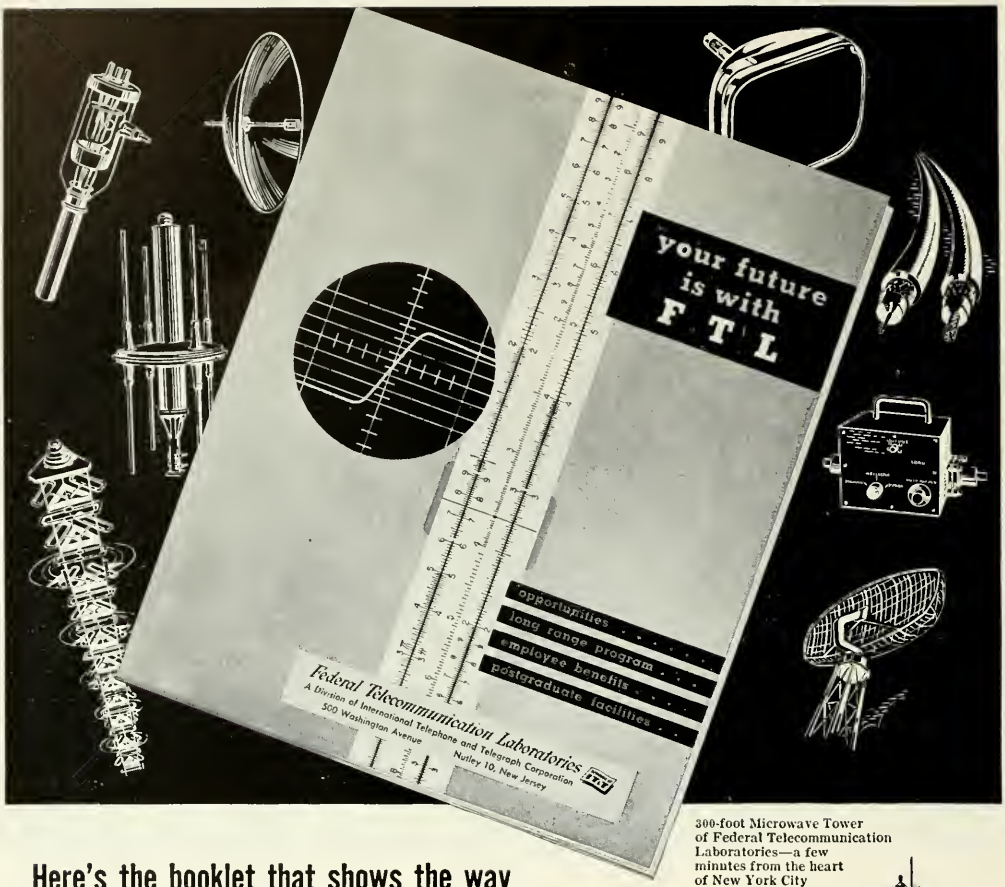
Boeing engineering activity is concentrated at Seattle, Washington, and Wichita, Kansas—communities with a wide range of recreational opportunities as well as schools of higher learning. The company will arrange a reduced work week to permit time for graduate study and will also reimburse tuition upon successful completion of each quarter's work.

There are openings in *all* branches of engineering (mechanical, civil, electrical, aeronautical and related fields) for DESIGN, PRODUCTION and RESEARCH. Also for physicists and mathematicians with advanced degrees.

For further information, consult your PLACEMENT OFFICE, or write

JOHN C. SANDERS, Staff Engineer — Personnel
Boeing Airplane Company, Seattle 14, Wash.

BOEING



300-foot Microwave Tower of Federal Telecommunication Laboratories—a few minutes from the heart of New York City

Here's the booklet that shows the way to successful careers in radio and electronics

"Your future is with FTL" could be the most important booklet you ever read! Briefly but comprehensively, it tells the story of Federal Telecommunication Laboratories . . . one of the nation's leaders in the development of radio and electronic equipments . . . one of the major units of the world-wide group of laboratories, factories and communication systems operated by the American-owned International Telephone and Telegraph Corporation.

To young engineers of ability and initiative "FTL" offers a fertile field for achievement, recognition and advancement . . . for a stable, productive future in long-range activities.

Send today for "*Your future is with FTL*". . . containing illuminating data on opportunities, employee benefits and other advantages in building a career where *big* things are happening in radio and electronics.

MAIL THIS COUPON TODAY

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500 Washington Avenue, Nutley, N. J. 1T-5

Please send me a copy of your descriptive booklet: "*Your future is with FTL*"

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Federal Telecommunication Laboratories
DIVISION OF I T & T

A Division of International Telephone and Telegraph Corporation

The metal that thrives on punishment

Steel serves you better when manganese is added —because the harder it works, the tougher it gets

EVER WATCH a power shovel bite into earth and rock? And wonder how the teeth of the steel bucket can endure such punishment? The amazing answer is that the teeth not only endure such treatment—they actually get harder because of it!

MANGANESE HOLDS THE SECRET—The story behind this remarkable steel is the unusual metal called *manganese*. The hundreds of thousands of tons of manganese required each year by steel and other metal-making industries are obtained by refining huge quantities of ore that come from mines in widely scattered points across the face of the globe.

ADDED TO STEEL—All steel contains manganese. A small amount "cleanses" molten steel and removes impurities. A larger amount of manganese makes the steel tougher and stronger.

FROM ORE TO ALLOY—Transforming raw ores into a variety of manganese alloys for the metal-producing industries is one of the many important jobs of the people of Union Carbide.

STUDENTS AND STUDENT ADVISERS: *Learn more about career opportunities with Union Carbide in* ALLOYS, CARBONS, CHEMICALS, GASES, *and* PLASTICS. *Write for booklet C-2.*

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SYNTHETIC ORGANIC CHEMICALS
DYNEL Textile Fibers
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teeth for a 1000 h.p. bite...

Undoubtedly you will recognize this application of a familiar technique for studying stresses. In this case, it was used to develop gears that are less than 5 inches in diameter yet easily transmit over 1000 horsepower.

Inherently, the design and development of aircraft engines offers unusual opportunities for applying basic engineering principles learned in school. In few other places can a technical graduate utilize his education and abilities more fully — gain recognition and advancement.

Many of our engineers who had important roles in developing the most powerful jet engine known to be in production — rated in the 10,000-pound thrust class — are still in their twenties.

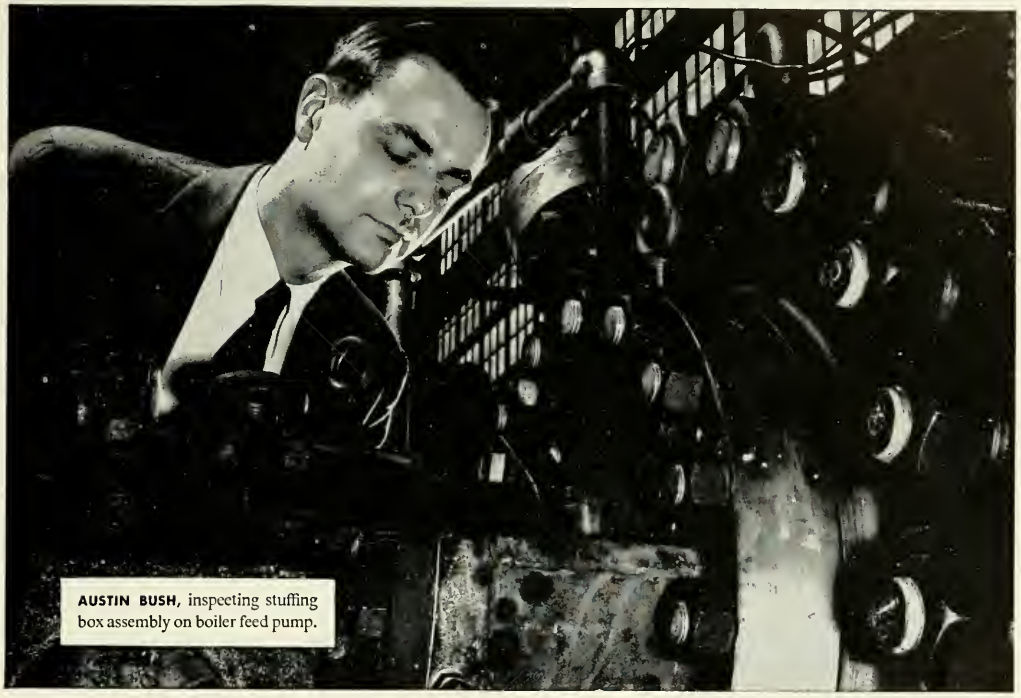
To those young graduates who can see the career possibilities in the rapidly evolving field of aircraft propulsion, we can offer a real opportunity for growth and professional development.

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

East Hartford 8, Connecticut

Austin Bush, Rensselaer, '50, Helps Develop New Pump



AUSTIN BUSH, inspecting stuffing box assembly on boiler feed pump.

Reports interesting project engineering assignments at Worthington

"Despite its size as the leading manufacturer in its field," says Austin Bush, "I have found Worthington pays considerable attention to the interests of the individual. The company's excellent training program consists of several months of working with the various types of equipment manufactured, augmented by technical lectures, and talks on the organization of the corporation.

"Following this training, I was given an opportunity to choose the department in which I wanted to work—engineering, sales, or manufacturing. My choice was the engineering department where I have already been assigned to several interesting projects.

"In addition to the training program, the members of our engineering department hold monthly seminars at which engineering topics of general interest are discussed.

"Opportunities for advancement are good, and pleasant associates make Worthington a fine place to work."

When you're thinking of a good job, think *high*—think *Worthington*.

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, New Jersey.

WORTHINGTON

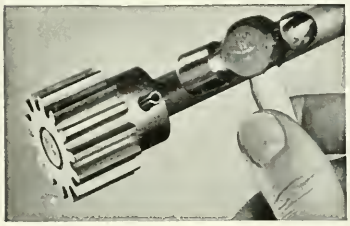
The Sign of Value Around the World

2.54X

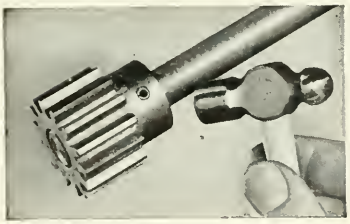
Where will you use this simple fastener?

Rollpin is driven into holes drilled to normal production-line tolerances.

No threading, peening or precision drilling with ROLLPIN



It compresses as driven.



Rollpin fits flush . . . is vibration-proof.

Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

This modern fastener drives easily into standard holes, compressing as driven. Its spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole.

* * *

If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your costs. Mail our coupon for design information.

Elastic Stop Nut Corporation of America
Dept. R16-CM, 2330 Vauxhall Road, Union, N. J.

Please send me the following free fastening information:

☐ Rollpin bulletin
☐ Elastic Stop Nut bulletin
☐ Here is a drawing of our product. What fastener would you suggest?

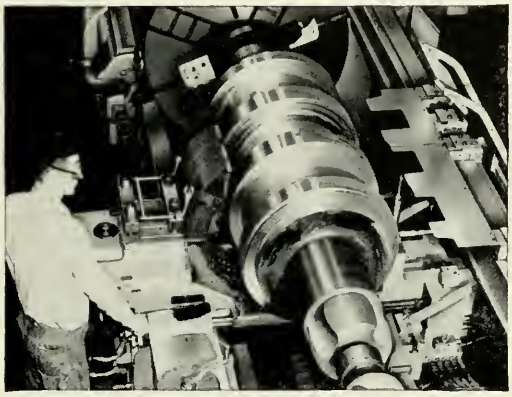
Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

Another page for **YOUR BEARING NOTEBOOK**

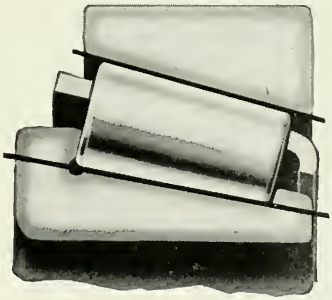


How to hold a heavily-loaded lathe spindle in accurate alignment

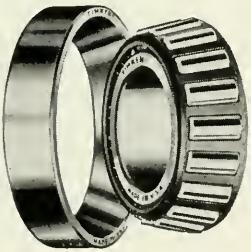
This big lathe machines rolls for steel mills. The roll is rotated by the lathe spindle and it must be machined to very accurate dimensions. So the lathe manufacturer, LeBlond Machine Tool Company, mounts the spindle on Timken® tapered roller bearings. Despite the great weight on the spindle, the Timken bearings hold it precisely in place—because they are made so accurately and have such high load capacity.

Why TIMKEN® bearings have high load capacity

This picture shows why Timken bearings have such high capacity—the load is carried on a *full line contact* between the rollers and races in the bearing. Note also the tapered construction. This permits the bearing to be tightened up (preloaded, we call it) to prevent chatter in rotating parts like the machine tool spindle above.



TIMKEN
TRADE-MARK REG U S PAT OFF
TAPERED ROLLER BEARINGS



Want to learn more about bearings or job opportunities?

Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, Ohio.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

Ball-ond-socket joint cast iron pipe for water main crossing river at Newark, Ohio.

Where installations are planned for long-term service to assure low cost per service year, engineers rely on east iron pipe as a dependable and adaptable material. Consequently, it is specified for a wide variety of applications, both utility and industrial, including water supply, sewerage, fire protection, process industries and many forms of special construction. Long life and low maintenance cost are *proved* results of the high beam-strength, compressive-strength, shock-strength and effective resistance to corrosion of cast iron pipe. Cast Iron Pipe Research Association. Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3, Ill.

Cast iron water main still functioning in Philadelphia after 135 years of service.

CAST IRON PIPE SERVES FOR CENTURIES

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Photography reads the meters *2500 an hour!*

Dial a call—an accurate register counts it—then each month photography records the total, precisely right, ready for correct billing.

TWENTY-FOUR hours a day, hundreds of thousands of dial phones click their demands in many central exchanges of the New York Telephone Company.

Little meters keep careful tally of the calls. Then the night before each bill is dated, photography reads the up-to-the-minute totals in a fraction of the time it could be done in any other way. Here is an idea that offers businesses everywhere simplification in copying readings on meters, dials or other recording instrumentation.

Photography fits this task especially well for two reasons. It is lightning fast. It can't make a mistake.

This is another example of the ways photography saves time, cuts costs, reduces error, improves output. In large businesses—small businesses—photography can do big jobs. In fact, today so many new applications of photography exist that graduates in the physical sciences and in engineering find them valuable tools in their new occupations. Other graduates—together with returning servicemen—have been led to find positions with the Eastman Kodak Company.

If you are interested, write to Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company
Rochester 4, N. Y.

At New York Telephone Company exchanges a unique camera records the dial message register readings—up to 25 at a clip—saving countless man-hours of labor, assuring utmost accuracy and at the same time providing a permanent record.

Kodak
TRADE-MARK

10 ways to build a successful career

Few companies can offer as broad a range of career opportunities as General Electric. Whether a young man is interested in science or engineering, physics or chemistry, electronics or atomic energy, plastics or air conditioning, finance or sales, employee relations or advertising, marketing or metallurgy—he can find a satisfying, rewarding career.

The development programs shown here are "open doorways" that lead to highly successful careers in a Company where big and important jobs are being done, and where young people of vision and courage are needed to help do them.

If you are interested in building a G-E career after graduation see your college placement officer, or write:

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